FARM AND GARDEN INSECTS

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FARM AND GARDEN INSECTS

BY

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WITH FORTY-SIX ILLUSTRATIONS

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PREFACE

THIS book contains a short general introduction to entomology, and an account of the identification, life-history, prevention, and eradication of such insects as may, annually or periodically, be expected to give trouble to the farmer or gardener.

Space, however, does not permit of the inclusion of the pests of fruit trees, which, with forest insects, may well form a suitable subject for a future volume. The present work, then, deals only with the more important insects that attack herbaceous perennial and annual plants, and farm animals.

The illustrations have been prepared by my colleague, Mr. Alexander Meek, M.Sc., F.Z.S., and are original except where otherwise indicated. I have also to acknowledge the use of Figures Nos. 5, 17, 40, from *The Cambridge Natural History*, Vol. V.; No 7, from Badenoch's *Romance of the Insect World*; and Nos. 11, 34, 36, from Wright's *Primer of Horticulture*.

My thanks are due to Mr. A. E. Brooke Hunt, B.A., for valuable assistance with the proofs.

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AUTHORITIES WHOSE NAMES ARE CONTRACTED IN THE TEXT:—

Bjerk.	=	Bjerkander
Curt.	=	Curtis
Fab.	=	Fabricius
Fürst.	=	Fürstenberg
Gerl.	=	Gerlach
Gn.	=	Guénée
Gyll.	=	Gyllenhal
Hal.	=	Haliday.
Kalt.	=	Kaltenbach
Kuts.	=	Kutschera
L.	=	Linnæus
Ltr.	=	Latreille
Még.	=	Mégnin
Mg.	=	Meigen
Redt.	=	Redtenbacher
Scop.	=	Scopoli
Sim.	=	Simon
Tr.	=	Treitschke
Zell.	=	Zeller

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FARM AND GARDEN INSECTS

INSECTS, on account of their possessing in the adult stage six feet, constitute the class Hexapoda in the animal kingdom.

Briefly described, the chief characteristics of the class are these. The body is composed or built up of a number of joints or segments which are grouped in three well-marked regions—the head, thorax, and abdomen (Fig. 1). The outer covering consists of a horny substance called chitine, which varies as regards hardness in different species, and in different stages and parts of the same species, but which is never absent except at the articulations of the segments, and at the minute apertures which occur at various parts of the insect's body. This chitinous crust gives rigidity to the insect, and forms an outer skeleton to which the muscles are attached. The head always bears one pair of organs called antennæ, while the thorax is always provided with six jointed legs, and may also be furnished with, at most, two pairs of wings. Breathing is performed through a number of small lateral apertures, and these communicate with fine ramifying tubes which carry the air to all parts of the insect's body, including the wings. Insects all

begin life as an egg,[1] and from that stage till they are perfectly developed, they undergo peculiar and

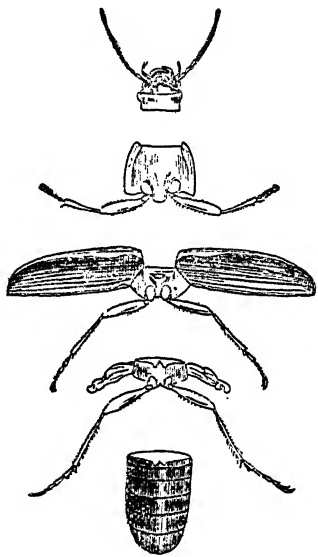


FIG. 1.—A disarticulated beetle, showing the main divisions of an insect's body: the head, with antennæ and mouth parts; the prothorax, with a pair of legs; the mesothorax and metathorax, each with a pair of legs and a pair of wings; and the abdomen.

generally well-marked changes which are termed metamorphoses.

[1] Examples of viviparous reproduction do not disprove the rule, for in such cases the egg is merely hatched before leaving the parent insect's body instead of afterwards.

THE ANATOMY OF INSECTS.

The Head of an insect consists of four segments, which, however, are so thoroughly fused together as to be unrecognisable in the adult form. The ground for the belief that four segments enter into the composition of the head need not here be discussed. The chief organs borne by the head are the antennæ, the eyes, and the mouth parts.

The antennæ, of which there is a pair, are inserted near the eyes. Their exact function has not yet been

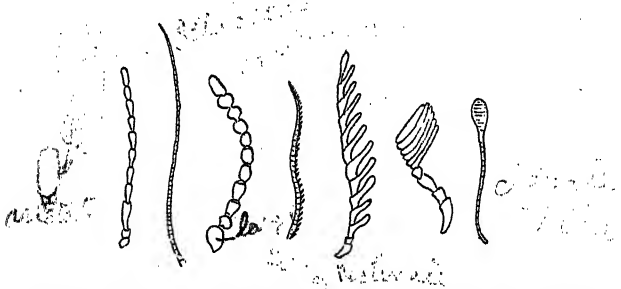


FIG. 2.—Antennæ: filiform, setaceous, moniliform, serrate, pectinate, lamellate, and clavate, in the order named.

clearly made out, but there seems no reason to doubt that they are sense-organs of some sort, probably serving as organs of hearing, smelling, and touching. They vary greatly in size, in some cases being much longer than the insect's body, while in others they are not so long as its head. The number of articulations is a widely variable one, while the shape or structure also presents many forms (Fig. 2). If approximately of equal thickness throughout, like a thread, the antennæ are said to be *filiform;* if gradually

tapering to a point, like a bristle, *setaceous*; if each segment is nearly globular, the whole resembling a string of heads, *moniliform*; if the segments are expanded laterally on one side, like the teeth of a saw, *serrate*; if the lateral processes are still more pronounced, like the teeth of a comb, *pectinate*; if the terminal segments alone are laterally expanded, *lamellate*; if the terminal segments are swollen to form a knob or club, *clavate*, &c.

In many insects, notably the weevils, the antennæ are elbowed, that is to say one portion of the antenna forms an angle with the next. When the basal joint, or basal joint but one, is markedly longer than any of the others, it is called the scape. If the end joints are swollen they constitute the clavola or club. The joints between the scape and club are collectively known as the funiculus.

The eyes of insects are of two kinds, simple and compound (Fig. 3). A simple eye (*ocellus* or *stemma*) consists of a bi-convex thickening of the cuticle, and, in the mature insect, is situated on the upper part of the head. Ocelli are the only visual organs met with in caterpillars, which usually possess twelve, while in mature insects they are frequently present in addition to compound eyes, but seldom occur alone. In adult insects these simple eyes vary from one to three in number, in different species, the latter being the usual case. Beetles, as a general rule, do not possess ocelli.

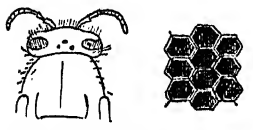


FIG. 3.—Head of a wasp, showing two large reniform compound eyes at the sides, and three simple eyes in the middle. A portion of a compound eye is shown magnified to the right.

Compound eyes (*oculi*) are made up of the union

of a large number (up to 30,000) of simple eyes, and when viewed through a pocket lens or microscope are seen to consist of hexagonal facets. The compound eyes are usually very prominent objects, and are frequently so large as to occupy the greater part of the head.

The Mouth Parts (Fig. 4) consist, in their simple form, of the upper lip (*labrum*), two pairs of jaws (the *mandibles* and *maxillæ*), and the under lip (*labium*).

The labrum is a narrow, chitinous fold which closes the mouth from above.

The mandibles, or upper jaws, are inserted on either side of the opening of the mouth and move horizontally. They are specially well developed in insects that have to tear or gnaw tough or hard substances.

The maxillæ, or under jaws, are attached immediately behind the mouth. They are much more complicated than the mandibles, and bear appendages, of which the most important are jointed structures called the maxillary palpi.

The labium, or second maxillæ, which is inserted on the under part of the head, also bears palpi, which in this case are called labial palpi.

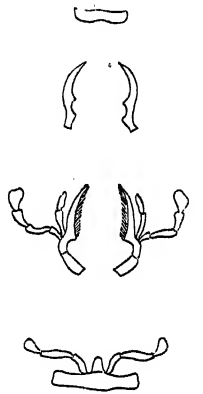


FIG. 4.—The disarticulated mouth-parts of a beetle, exhibited in the following order: labrum, mandibles, maxillæ consisting of the inner and outer lobes and palpi, and labium with its palpi and tongue or lingua. (After Schoch.)

The mouth-parts of insects are liable to vary greatly in the different orders and families, and their examination is often a matter of some difficulty.

Most of the parts may, however, be made out with comparative ease in any of those large beetles (Carabidæ) which one so frequently meets with under stones, or in turning up the soil of a well-manured garden. In butterflies and moths, which live chiefly on the nectar of flowers, the mandibles are very rudimentary, whereas the maxillæ are transformed into a long tube by means of which the juices are easily extracted from the flowers. In the flies (*Diptera*) the mouth is also adapted for sucking, whereas the beetles have a biting mouth, and the bees are capable of both biting and sucking.

The Thorax consists of three segments (Fig. 1), to each of which a pair of legs is attached, so that an insect has altogether six of these appendages. The first of the thoracic segments (*prothorax*) is generally the one that is best seen from above, and in the beetles and some other insects is so prominent as to be popularly called *the* thorax. The second segment (*mesothorax*) bears a pair of *wings*—except of course in the case of wingless forms—while the third segment (*metathorax*) also bears a pair of wings, except in the order Diptera, where the hind wings are very rudimentary, and go by the name of poisers or halteres. In the beetles the fore-wings (those attached to the mesothorax) are hard and rigid, being useless as organs of flight. They, however, act as cases or covers for the membranous hind wings, and are known as elytra (Fig. 1).

Apterous—*i.e.* wingless—species of insects (*e.g.* lice) occur in most orders, while in others the wings are very rudimentary and incapable of being used as organs of flight (*e.g.* the female Winter Moth).

The wings may be covered with scales, as, for instance, in the case of the butterflies and most moths. Frequently the hind wings are coupled to

those in front by hooked hairs, so as to assist flight.

The upper portion of a thoracic segment is called the *notum*, the lower portion the *sternum*, while the sides bear the name of *pleura*, so that we have the *pronotum*, *prosternum*, *mesonotum*, *mesosternum*, &c. In Coleoptera and Orthoptera it is the pronotum that is chiefly visible from above when the wing cases are folded.

The leg of an insect (Fig. 5) is largely used for purposes of classification. Beginning at the body it consists of the following parts:

The *Coxa* is the joint by which the leg is attached to the thorax.

The *Trochanter* is the next joint, usually a very small one.

The *Femur* is generally much longer than the first two, and is usually the stoutest joint of the leg.

The *Tibia* comes next and, as a rule, is the longest portion of the leg. It is usually provided with one or more spurs or spines.

The *Tarsus* or foot may consist of from one to five segments, the last joint being furnished with claws, and sometimes also with cushions by means of which certain insects are enabled to climb smooth surfaces.

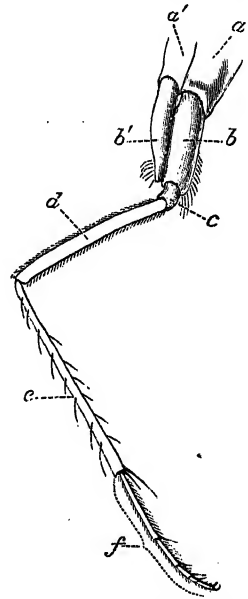


FIG. 5.—The leg of an insect of which the essential parts are: the coxa, *b*; the trochanter, *c*; the femur, *d*; the tibia, *e*; and the tarsus, *f*; *a* and *a'* are parts of the sternum, while *b'* is a support to the coxa, met with in some insects.

For purposes of digging, swimming, springing, &c., the legs of insects may be variously modified.

The Abdomen may consist of as many as ten segments, which may be freely jointed or immovably united to each other. Certain of the abdominal segments may be rudimentary or altogether abortive, or may be embraced by larger ones and so be invisible. The perfect insect has never any ambulatory appendages attached to the abdomen, and indeed this region seldom bears appendages of any kind, exceptions occurring, however, in the case of insects with ovipositors (many Hymenoptera), forceps (earwigs), bristle-like structures (cockroach), &c.

These remarks on the number of legs, and the general absence of appendages from the abdomen, apply only to the perfect true insect. Larvæ have frequently a much greater number of legs than six, and the additional legs (prolegs) are always situated on the abdominal segments.

The Alimentary System of Insects (Fig. 6) is comparatively simple, and consists essentially of a tube which extends from the mouth to the anus. This tube is generally more or less convoluted, and shows a certain amount of differentiation, the various parts subserving special purposes. The *Pharynx* is situated in the head, and leads into the *Œsophagus*, which is chiefly located in the thorax. Connected with the *Œsophagus* there is frequently a *crop*, in which the food is stored, and a *gizzard*, in which it is disintegrated.

The third main division of the alimentary system is the *stomach*, which is usually the largest compartment, and this leads into the intestine, which may be differentiated into *ileum*, *colon*, and *rectum*. Along the course of the alimentary canal one finds several glands for the secretion of digestive juices (such as

saliva and so-called bile), glutinous substances (such as silk), or acid or poisonous discharges employed for purposes of protection.

THE CIRCULATORY SYSTEM.—The blood of insects is generally colourless, but may be green, yellow, or red. The chief organ concerned with the circulation of the blood is a vessel, situated near the dorsal surface of the abdomen, which is called "the heart." It shows a number of contractions corresponding to the abdominal segments, and is furnished with valves which direct the flow of blood towards the head. From the heart the blood flows forward through the *aorta* into the thorax and head, though the greater part of the circulation is not confined to vessels but takes place in the body-cavity and in the vacant spaces in the appendages. When the heart contracts those valves open to admit of the forward

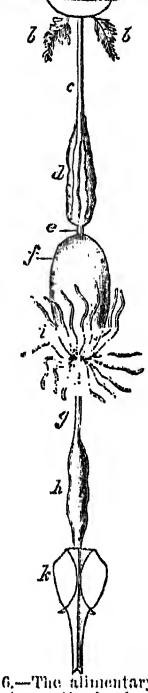


FIG. 6.—The alimentary system of an insect: *a*, the head; *b*, salivary glands; *c*, œsophagus; *d*, crop; *e*, position of gizzard; *f*, stomach; *g*, small intestine; *h*, large intestine; *i*, Malpighian tubes (urinary organs); *k*, termination of body. (After Dufour.)

flow of the blood, and when it dilates they are closed and a set of lateral valves open to admit of the entrance of blood from the abdominal cavity.

THE RESPIRATORY SYSTEM.—Insects do not take in air by their mouth, but by means of apertures called *spiracles* or *stigmata*, which are situated on the sides of the thoracic and abdominal segments. Usually in the mature insect one finds a pair of spiracles on the meso- and metathorax, and eight pairs on a corresponding number of abdominal segments. In caterpillars, on the other hand, spiracles are present on the first segment behind the head, but are absent from the next two as well as from the caudal segment. The spiracles are very prominent objects along the sides of large caterpillars and are protected against the entrance of dust by means of fringes, sieves, &c. They lead directly into the *tracheæ*, which are tubes strengthened by spiral coils of chitine. The tracheæ conduct the air to all parts of the body, and thus secure thorough aeration of the blood.

THE METAMORPHOSES OF INSECTS.—Apart from a few exceptional cases insects lay eggs. The eggs show a variety of shape, and the shell may be smooth or beautifully sculptured. Eggs are deposited singly or in groups, generally in contact with, or in the immediate neighbourhood of, a supply of food which will serve for the nourishment of the young larvæ. Thus many insects deposit their eggs on leaves, others in stems or under bark, others again on animal substances such as meat, or on cattle. The number of eggs laid by a single insect varies between a dozen, or even less, and 50,000, most insects laying from 50 to 120. After a longer or shorter interval, depending chiefly upon the insect-species, the egg hatches and a tiny creature crawls forth

which is known as the *larva, caterpillar, grub,* or *maggot.* The term larva may be used to denote the second stage of any insect, but there is a tendency to confine the term caterpillar to the larvæ of butterflies, moths, and sawflies; grub, to the larvæ of beetles; and maggot, to the larvæ of flies.

The three segments behind the head correspond to the thorax of the imago, and, if legs are present at all, these segments bear a pair each. Legs are also frequently present on the more posterior segments, but they differ from the thoracic legs in not being jointed, and also in being provided with fringes of bristles instead of claws. These are called pro-legs or claspers, of which there may be as many as five pairs on the larvæ of butterflies and moths, and eight pairs on the larvæ of sawflies. The head and fourth body segment never bear legs of any kind.

A typical larva, such as a caterpillar, possesses a head and twelve other segments. It is not always possible to determine the order to which a larva belongs, but the following characteristics are generally applicable. The larvæ of Coleoptera have a horny head and biting jaws, and have either six jointed legs (cockchafer, &c.), or none (weevils, &c.). The larvæ of Lepidoptera have a well-marked head with biting jaws, and in a typical example each of the three thoracic segments bears a pair of jointed legs ending in a single horny claw; the fourth and fifth segments have no appendages; the sixth, seventh, eighth, and ninth have each a pair of prolegs; the tenth and eleventh rings are destitute of legs; while the twelfth segment bears the caudal prolegs which, however, in a few instances are absent. In the majority of cases there are thus sixteen legs, and this is the greatest possible number for the caterpillars of butterflies and moths. In the Geometridæ, or

"Loopers," it is only on the ninth and twelfth segments that we find prolegs, so that there are but ten in all; while in other Lepidopterous larvæ the number of legs may be twelve (Y-moth) or fourteen (Puss moth). The larvæ of the Hymenoptera may be footless (*e.g.* bees, corn sawfly, &c.), or they may possess six (wood wasps, &c.), or eighteen to twenty-two (*true* sawflies) ambulatory appendages. The larvæ of Diptera are footless and generally headless (maggots); those of the Neuroptera have a biting mouth, and may have twenty-two legs; and those of Hemiptera and Orthoptera generally possess six feet.

In most cases it is during the larval stage of its existence that an insect is most voracious and consequently most destructive. The amount of food consumed by a caterpillar, for instance, in a day is frequently many times its own weight. In consequence of the rapid assimilation of food larvæ usually grow at a great rate, and as the chitinous covering is capable of but slight distension, a time soon arrives when the creature requires to throw off its skin—to *moult*, as it is called—so as to provide for its increase in size. During its existence as a larva an insect usually moults five times, after which it assumes its third form and becomes a *pupa* or *chrysalis*. In the pupal stage a metabolic insect is perfectly quiescent, taking in no food but living entirely upon a store of fat (the "fatty body") which is accumulated during the larval stage. In the course of time the membrane or case containing the pupa cracks, and the perfect insect or *imago* creeps out to lay its eggs and reproduce the species like its predecessor.

The changes from larva to pupa, and from pupa to imago, are called *metamorphoses*. When there are well-marked distinctions between these stages the

metamorphosis is said to be *complete*, and the insects are termed *metabolic*. About ninety-five per cent. of the total number of insects are metabolic; complete metamorphosis characterising the orders—*Coleoptera*, *Hymenoptera*, *Neuroptera*, *Lepidoptera*, and *Diptera*.

Where it is difficult or impossible to determine the limits of the larval or pupal stages—that is to say, where the larva gradually changes into the pupa, or the pupa into the imago—the metamorphosis is said to be *incomplete*, and the insects are termed *ametabolic*. This state of things is generally met with in the orders *Hemiptera* and *Orthoptera*. Where the metamorphosis is incomplete it has been suggested to call the immature insect a *nymph*, a term which was formerly synonymous with pupa. Although the nymph bears a strong resemblance to the perfect insect it may usually be distinguished by the smaller number of joints of the tarsus or antenna, or by the absence of wings. In cases, however, where the imago is wingless (*e.g.*, lice), it is frequently impossible to determine with certainty the stage in which the insect is found.

The Colour of Insects may be very constant or it may vary to such an extent as to make individuals of the same species difficult of recognition. Variation in coloration may be due to the character of the food, but is generally induced by the colour of the surroundings (Fig. 7). In the latter case it is a natural device on the part of the insect for enabling it to escape the notice of its enemies. A caterpillar, for instance, may be green in colour when it is feeding on green leaves, but should it desert the foliage and crawl on to a brown surface, such as the bark of a tree, for the purpose of pupating it may rapidly assimilate the colour of its new surroundings and become of a brownish tint.

Not only do insects make use of colour for protective purposes, but they also adapt their appearance in other ways to the character of their surroundings. This protective similarity, as it is

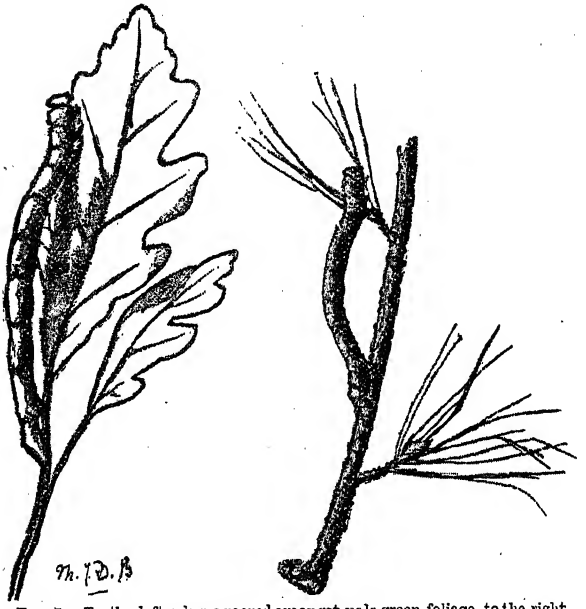


FIG. 7.—To the left a larva reared amongst pale green foliage, to the right a larva of the same species reared amongst darker foliage.

called, is well illustrated in many looper caterpillars, whose attitude of repose so much resembles a twig that the creatures are most difficult to detect (see Fig. 7). Grasshoppers, too, resemble very closely the objects by which they are generally surrounded, and

some caterpillars that feed on leaves are strikingly like the parts of the plant on which they are found.

Another common device which insects employ for purposes of self-preservation is that of mimicry. In this case a harmless insect assumes the form of some insect that is distasteful to, or well able to protect itself against its enemies, and is consequently left alone. Certain Clear Wing moths, for instance, so closely resemble hornets or wasps as almost to defy recognition.

Primary and Secondary Sexual Characters.

In the case of some insects it is only by a careful examination of the genital organs that the sex can be determined. In others, however, there are secondary characters peculiar to the sex which enable us to distinguish males and females almost at a glance. In the case of the Large White Cabbage Butterfly, for instance, the female has two conspicuous black spots near the centre of each fore-wing (Fig. 29), whereas the fore-wings of the male are practically destitute of such markings. The male cockchafer has more strongly lamellated antennæ than the female, and the latter has also one lamella fewer. The antennæ of male moths are generally serrated, whereas in females they are setaceous. The Winter Moth (Cheimatobia brumata) is winged and capable of flight in the male sex, but wingless in the female. The female is usually larger than the male (*e.g.* sawflies), but may be smaller (*e.g.* the earwig). The female firefly (a Coleopterous insect) somewhat resembles a grub, whereas the male has elytra and the other characters of the beetles.

The Generation or life cycle of an insect means the period that elapses from the time the eggs are

deposited until the perfect insects that ultimately develop from these eggs are themselves in a position to oviposit. Generally speaking, the duration of a generation is fairly constant for any particular species, though the character of the weather, and the supply of food, may shorten or prolong the duration of the generation. A generation is said to be *annual* —the commonest case—when the life cycle is completed once in a year (*e.g.* the Great Yellow Underwing Moth), *biennial*, when two years are necessary (*e.g.* the Leopard Moth), *triennial*, when three years are required (*e.g.* the Wireworm), *quadrennial*, when four years are needed (*e.g.* the Cockchafer), and so on. The most prolonged insect generation that is known occurs in the case of an American locust (Cicada septemdecim), which, as its name implies, takes seventeen years to complete the life cycle.

On the other hand there may be more than one generation in twelve months, and then we may have a double generation (*e.g.* the Large White Cabbage Butterfly), a triple generation (*e.g.* the Frit Fly), a multiple generation (*e.g.* Plant lice), &c.

Before an insect attack can be successfully combated, one must be familiar with the life history of the pest, or otherwise one will not know the stage of development in which the insect will be found at any particular season of the year. The two stages that overlap most—and, in fact, overlap at all in most cases—are the first and last, that is to say the stages of egg and imago. When insects are on the wing they are, for the most part, on the look out for suitable places in which to deposit their eggs, and when this has been accomplished a speedy death generally terminates their existence. The duration of the life of an imago is usually a question of days—

it may even be hours—though some live for weeks, and even months, after ovipositing, *e.g.* the Pine Weevil.

Insects hibernate in all the four stages of their development, though for any particular species the stage is practically constant. Thus most Aphides pass the winter as an egg, the Great Yellow Underwing as a larva, the White Cabbage Butterfly as a pupa, and the common Tortoiseshell Butterfly as an imago.

Insect Reproduction.

In the great majority of cases the reproduction of insects is sexual (Fig. 8). The male unites with the female and injects a supply of spermatozoa into a pouch (the seminal receptacle) which opens into the oviduct. When an egg is in process of being laid the female voluntarily ejects a portion of the spermatozoa from the seminal receptacle, and the male fertilising material, coming into contact with the ovum during its passage down the oviduct from the ovaries, enters by the micropyle and fertilisation is complete. As a result, the formation of the embryo inside the egg begins, and in the process of time the shell cracks and the larva appears.

A deviation from this normal type is furnished by the Dipterous family Pupipara, which includes the well-known Sheep Ked. Here the egg is not only hatched out in the insect's body, but the maggot that results remains so long in the oviduct of its mother —where it is nourished by a fluid secreted by special glands—that when it is at last expelled from the parent's body it immediately passes into the pupal condition. Certain other flies, as well as the Aphidæ, exhibit viviparous reproduction, but on the whole such a state of things is not common.

Parthenogenesis—that is, reproduction without the intervention of the male—is relatively common amongst insects. It occurs, not unfrequently, amongst moths, and is the normal state of things in the case of certain insects. The perfect female bee (the queen) receives a stock of spermatozoa from a

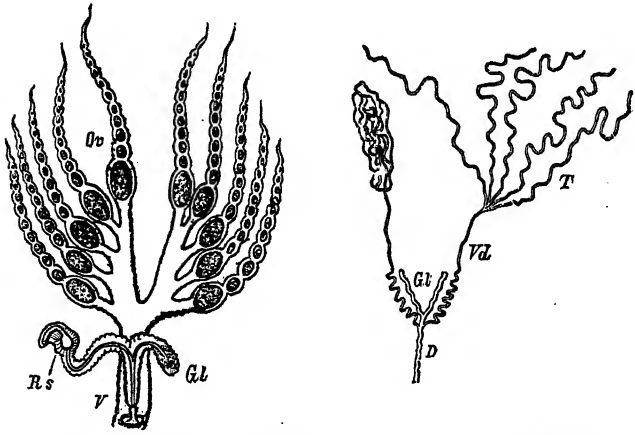


FIG. 8.—The genital organs of insects. To the left the female organs: *Ov*, the ovarian tubes; *Rs*, the seminal receptacle, opening into the oviduct; *V*, the vagina; *Gl*, an accessory gland. To the right the male organs: *T*, the testes; *Vd*, the vasa deferentia, which conduct the spermatoza to *D*, the duct which leads to the penis; *Gl*, accessory glands. (After Stein.)

male, and according as she lays unfertilised or fertilised eggs, so males (drones) or females (queens and workers) are produced. The queen bee thus appears to be capable of begetting males or females at will, and this she does according to the requirements of the hive. The males, being produced from unfertilised eggs, are the result of parthenogenetic

reproduction; the females, on the other hand, constitute examples of sexual reproduction. Although, when young and vigorous, the queen may produce drones or workers at pleasure, it not unfrequently happens that in the process of time the stock of spermatozoa in her seminal receptacle is exhausted, and then she has no choice but to lay unfertilised eggs, and so to produce drones.

It also happens amongst certain insects (*e.g.* Cynipidæ) that the fertilised eggs produce males, and the unfertilised eggs females. In this case, then, it is evident that males are not absolutely necessary for the perpetuation of the species, and, indeed, the male sex of certain insects (*e.g.* Cynips tinctoria, which induces the formation of galls on oaks in the Levant and elsewhere) is altogether unknown.

The Green Flies (Aphidæ) occupy a peculiar position amongst insects. From eggs, which are laid in autumn and hatched in spring, imperfect females are produced. These reproduce, viviparously and parthenogenetically, other similar females during summer, and it is not usually until autumn that both sexes appear, when the female lays fertilised eggs which remain unhatched over winter, and give rise to the first brood of imperfect females in the following spring.

Insects in the Economy of Nature and of Man.

Insects—even the largest of them—are too small individually to do much damage or confer much benefit, but, on account of their capacity for rapid increase, they may and do collectively play a very important part, naturally and economically. They make their influence felt in nature:—

(*a*) **By destroying dead organic matter,** and in

this way they purify the atmosphere and the soil, convert inert materials into plant food, &c.

(*b*) **By serving as food for other animals**, many insects (*e.g.* Ichneumons), birds (*e.g.* swallows), and mammals (*e.g.* bats) being insectivorous.

(*c*) By **Fertilising Flowers**, many flowers (*e.g.* Geranium) being incapable of fertilisation except through the agency of insects.

Useful and Harmful Insects.—It is usual to arrange insects in two groups, according as they assist or resist man in his schemes. Such an arrangement, however, is very artificial, and must not be pushed too far, for it is evident that certain insects are neither wholly beneficial nor wholly injurious, or they may be useful under some circumstances and injurious under others. The same difficulty is experienced in the grouping of plants; timothy grass, for instance, being an excellent plant in a meadow, but a weed in a cornfield. And similarly with regard to birds, and animals generally, the rook being altogether useful when engaged in picking up grubs behind the plough, but distinctly injurious when it turns its attention to the ripening potato crop.

Insects may be directly or indirectly useful. As examples of the former we have the bee, the cochineal insect, the silk-moth, and many others, which yield products that are of direct benefit to man. As examples of the latter we have insects which prey upon destructive insects (*e.g.* the Ladybird), or which feed upon weeds (*e.g.* the Cinnabar moth, whose caterpillar is such a common object on the Ragwort).

Destructive insects may induce injury in a variety of ways. Thus they may—

(*a*) **Gnaw and destroy plant tissues**, and this form of injury characterises the attack of insects which are furnished with strong biting jaws (*e.g.* the cockchafer).

(*b*) **Extract the sap from plants,** as in the case of insects with sucking mouths (*e.g.* Green Flies).

(*c*) **Stimulate the production of swellings,** by the introduction into the plant of an irritating fluid (*e.g.* the Turnip-gall Weevil).

(*d*) **Irritate and unsettle live stock** (*e.g.* the Sheep Ked).

(*e*) **Damage animal products** (*e.g.* the ox warble fly, which not only interferes with the thriving of cattle, but also greatly reduces the value of their hides).

Harmful insects may be subdivided into those that are **physiologically,** and those that are **technically,** injurious.

Physiologically injurious insects cause damage by interfering with the vital functions of plants or animals (*e.g.* the Turnip Flea beetle).

Technically injurious insects possibly interfere but little with the health of the plants or animals they attack, but, on the other hand, they render vegetable or animal products less suitable for the uses to which they are usually applied (*e.g.* Sirex, a forest insect).

Many insects not only interfere with the health of plants or animals, but also reduce the technical quality of their products, that is to say, they are both physiologically and technically injurious (*e.g.* the ox warble fly, &c.).

In committing their ravages insects may, and usually do, confine their attack to one particular part of a plant. Thus, we have insects that attack only roots (*e.g.* the wire-worm), others that damage only stems (*e.g.* the corn sawfly), others only leaves (*e.g.* the Diamond-Back moth), and others only seeds (*e.g.* the Pea moth).

Many, in fact most, insects in their search for food,

or for a suitable place to deposit their eggs, confine their attack to a single genus, or order of plants. Such insects are termed **Monophagous** (*e.g.* the Pea Moth). Others, again, attack a large number of distinct genera or orders of plants indifferently, and are styled **Polyphagous** (*e.g.* most Surface Caterpillars, as, for instance, Agrotis segetum). **Zoophagous Insects** prey upon animals, or animal substances (*e.g.* the Blow Fly); and as a sub-class of zoophagous insects we have **Entomophagous Insects**, which prey upon other insects, and are, for the most part, useful (*e.g.* Ichneumons).

The Causes of Insect Devastation.—If we search carefully in our fields and gardens at the right season of the year we shall not be long, as a rule, in finding a few examples of nearly all our destructive insects. But so long as they remain numerically scarce no particular attention is paid to them, and indeed their presence may be overlooked altogether. Suddenly, however, and frequently without any warning, some particular species of insect appears in enormous numbers, and the farmer or gardener awakes to the fact that an insect plague is upon him, and that his crops are threatened with destruction. No doubt certain insects cause appreciable damage more frequently than others, but still there is a sort of periodicity in the recurrence of all insect ravages. The causes that lead up to such "Insect years" are very various, and cannot, in all cases, be definitely determined, but we may take it that the sudden appearance of swarms of injurious insects in our fields is due either to immigration from some other district or country, or to the rapid increase of those which are strictly indigenous to the locality.

Immigration from adjoining districts or countries is probably seldom the cause of an insect infestation,

though it was said that the swarms of Diamond Back moths, whose larvæ caused so much havoc in our turnip fields in 1891, were blown to this country across the North Sea from Scandinavia and Denmark. White Cabbage Butterflies, too, may frequently be encountered in large numbers far out at sea, and are doubtless borne to this country in certain states of the wind and weather from various parts of the Continent.

It is, however, to **rapid increase in the numbers** of the insects actually present in our fields that insect plagues are usually to be ascribed, and it is surprising how rapidly insects increase in numbers if conditions are even only moderately in their favour. The most extreme case is furnished by the aphides, a single female of which will continue for days producing young viviparously at the rate of about one per hour. In a short time the young themselves reproduce, and, as Huxley points out, if all the aphides that are born were to live, the produce of one female would, at the end of a single season, outweigh five hundred millions of men. Linnæus, recognising the marvellous rate of increase of insect life, stated that the body of a horse could not be more quickly consumed by a lion than by flies.

Taking, however, an insect—the Large White Cabbage Butterfly—which is not endowed with unusual fecundity, and allowing for a mortality of forty per cent. in each brood, we find that the rate of increase is as follows. Starting with the spring of 1896, a female lays 100 eggs, which by August—assuming the sexes equally divided—will have produced 30 egg-laying females. These, by the spring of 1897, will have produced 900 females, which—the insect having a double generation—by the height of summer will have increased to 27,000 females. Or,

stated in the form of a table, the increase appears thus :—

1	female	lays	eggs	in spring 1896	which	produce	30 fmls.
30	females	lay	,,	summer 1896	,,	,,	900 ,,
900	,,	,,	,,	spring 1897	,,	,,	27,000 ,,
27,000	,,	,,	,,	summer 1897	,,	,,	810,000 ,,
810,000	,,	,,	,,	spring 1898	,,	,,	24,300,000 ,,
24,300,000	,,	,,	,,	summer 1898	,,	,,	729,000,000 ,,

From which it will be seen that, even with a death-rate of forty per cent., our neglect to destroy a hibernated chrysalis in the spring of 1896 may lead to the presence of nearly a thousand million females in our fields and gardens in the spring of 1899. If White Cabbage Butterflies do not, as a rule, increase so rapidly, it is only because their enemies take a larger toll than even forty per cent.

The factors that chiefly favour the increase of insects are, **abundance of food** (*e.g.*, Cruciferous weeds encourage the increase of the Turnip Fly), **favourable weather**, and the **absence of their natural enemies** (*e.g.*, Entomophagous insects, Birds, Disease, &c.).

Not only does an insect plague occur, as a rule, with great suddenness, but it also disappears quite as rapidly. The rapid disappearance of swarms of insects is due to conditions unfavourable to insect life, and it is of interest and importance to look a little more closely at what these conditions are.

The Natural Agents that limit the Increase of Insects.

Rapid variations of temperature, especially frost at unexpected seasons, cause the death of large numbers of insects. Thus, late spring or early summer frosts, occurring as they do at a time when insects are not prepared for them, act as a powerful check to the pests, though they frequently have a disastrous effect

on plant growth as well. Severe winter frost, on the other hand, is practically powerless to affect insect life, and, in fact, by freezing the ground and thus preserving insects that hibernate there against the attack of birds, it is rather favourable than otherwise to insect increase.

Cold heavy Showers destroy caterpillars and imagines in large numbers, and it is probable that this kind of weather—which was specially characteristic of the month of July, 1891—was the cause of the sudden disappearance of the swarms of Diamond Back moths, and their caterpillars, that infested our fields in the summer of that year.

Violent Gales are also a natural check to insect increase. Butterflies and moths get blown against objects and killed during high winds, and caterpillars when blown off the plants on which they are feeding frequently never succeed in regaining their lost position. Simple dislodgement, in fact, is a well-known artificial eradicative process in the case of certain caterpillars (*e.g.* Turnip Sawfly, Diamond Back Moth, &c.), and dislodgment is in many cases naturally effected by gales.

Febrile Diseases, induced by Bacteria in the blood, are very common amongst insects, and it is chiefly owing to the ravages of such diseases that insect plagues rapidly vanish when they have reached their culminating point. The well-known Pebrine of silkworms and Foul Brood of bees are examples of diseases of this class. On the Continent attempts have been made, with a fair measure of success, to introduce disease artificially amongst injurious insects, and it is not unlikely that the artificial introduction of contagious diseases may ultimately rank amongst the most successful eradicative measures.

Fungoid Diseases, induced by the development of

the mycelia of fungi (of the groups Entomophthoreæ and Ascomycetes) in the bodies of insects, are also very frequently met with. Any summer or autumn one may observe dead house flies adhering to the window panes, while the glass in the immediate neighbourhood is partly obscured by a gray dust. Such flies have succumbed to the attack of a fungus, Empusa Muscæ, the encircling dust being the abjected spores (Fig. 9).

FIG. 9.—A fly killed by Empusa Muscæ, and surrounded by a zone of abjected spores. (After Nitsche.)

Entomophagous Insects act as a check upon the insects on which they prey. Such insects are all useful, on the whole, though it is not to be denied that they do, to some extent, prey upon other useful insects, or upon insects that are indifferent to the farmer or gardener.

Representatives of insect-devouring insects are met with in nearly all the orders. A very large number of *Beetles* (Coleoptera) live entirely, or for the most part, on insect food. The larvæ of the family Cicindelidæ make holes in sand in which they conceal themselves, ready to pounce upon any passing insect that they think they can master. The imagines pursue their prey by a series of leaps and bounds. The families of the Carabidæ, Staphylinidæ, Silphidæ, Histeridæ, Cleridæ, and others, all contain entomophagous species; but the most useful family of all is the Coccinellidæ (Ladybirds). These live amongst the leaves of all kinds of plants, where both the imagines and their active larvæ prey almost exclusively upon Green Flies and mites. They are specially welcome guests in hop gardens, where they do much to diminish the ravages of the destructive Hop Aphis.

The order *Hymenoptera* contains a large number of

most useful insects. The members of the great family of the Ichneumonidæ all deposit their eggs in the eggs, larvæ, pupæ, or imagines of other insects, and the resulting larvæ live as parasites in the bodies of their victims. The larval and pupal stages—especially the former—are most frequently selected by the Ichneumons for attack, less frequently the stages of egg or imago. In some cases only a single Ichneumon-egg is deposited in the host, and instinct enables the parasite to determine whether a host has already been utilised for oviposition or not. In other cases many, even hundreds, of eggs may be laid in the body of a single caterpillar, but in all cases the result is the same, namely, the ultimate destruction of the victim. The best known Ichneumon—using the term in its widest sense—is probably Microgaster glomeratus (Fig. 30), which, as a larva, lives in the caterpillar of the Large White Cabbage Butterfly. So common is this parasite that it is scarcely possible to collect a dozen caterpillars of this butterfly and rear them in a chamber, without finding that many of them have been stung by Microgaster. When ready to pupate, the Microgaster larvæ leave the body of their host and spin pale yellow cocoons on the sides of the chamber; or, in the open, on cabbage leaves, pailings, walls, &c. In the case of this parasite a large number of eggs are laid in the body of a single host.

Other Hymenopterous families that contain entomophagous species are Sphegidæ, Vespidæ, Formicidæ, &c.

The order *Diptera* contains some extremely useful insects, notably the genus Tachina. Many of the species of Tachina are about the size of a house fly, and deposit their eggs on caterpillars, into which the maggots force an entrance, living much in the same way as Ichneumons. Although not so common in this

country as the Ichneumons, the Tachininæ are by no means rare, and are frequently bred out of caterpillars that are being reared in confinement. The larvæ of certain species of Syrphidæ—popularly known as "Hoveres," from the way in which they poise or hover in the sunshine—live exclusively on aphides, of which they destroy enormous numbers.

The examples of entomophagous insects in the other orders are of less importance than those already indicated, though a Neuropterous insect, known as the Golden Eye, Lacewing Fly, or Plant Louse Lion (*Chrysopa perla*), which lives exclusively on aphides, must be classed amongst our most useful insects.

Insectivorous birds, as a natural check to the increase of destructive insects, are of no less importance than entomophagous insects. Certain birds, such as the woodpeckers, gold-crested wren, and tree-creeper, appeal more to the forester than to the farmer and gardener; while others, such as the tits, flycatchers, wren, robin, hedge-sparrow, and cuckoo, frequent woods and hedgerows rather than the open field. Other birds, again, like the rook and jackdaw, do a very considerable amount of damage in certain ways; while still others, such as the gulls and wagtails, are too local to be of general utility, though where they do occur they should certainly be welcomed. The most valuable bird in this country —regarded from the standpoint of economic entomology—is the starling, which, although sometimes convicted of consuming grain and fruit, is practically entirely useful. It is a bird of great activity, being almost incessantly engaged in its search for grubs—especially chafer grubs, wireworms, and leatherjackets; it is prolific, generally rearing two broods in a season; it is not a migrant, in the wider sense of the term, and is therefore with us during the whole

year, and being a fairly large bird it requires a relatively large amount of insect food for its support. Moreover, a great deal may be done to encourage the increase of the starling, and this matter should receive every attention at the hands of cultivators generally. The best way to attain this end is to erect a plentiful supply of nesting boxes on buildings, trees, or even poles. The most important point to be noted in the construction of these boxes is not to make the entrance hole too large, or otherwise the nesting chamber is too light, and this does not seem to suit the bird. A hole exactly two inches in diameter is the most suitable size, while the height may be twelve inches and the depth and breadth six inches (Fig. 10). If the boxes have been properly made, and have been erected in suitable places not later than February, they will all be occupied by starlings in the course of the ensuing season. Similar boxes, but of smaller proportions, may also be provided for tits, of which the great and blue species are most frequently met with in our gardens.

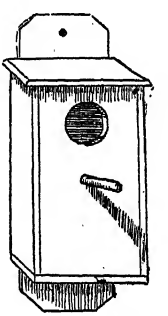


FIG. 10.—Nesting box for starlings.

Insectivorous Mammals are of much less importance than insectivorous birds, though insect food enters largely into the composition of the diet of many. The bat and shrew are entirely useful mammals; the mole destroys large numbers of grubs, though in tillage land or hayfields it is sometimes rather troublesome; while the weasel, fox, hedgehog, &c., though partially insectivorous, have practically no effect on insect life, as a whole.

General Preventive Measures.

While the special preventive measures applicable to each insect or group of insects may be best discussed later, when dealing with the insects concerned, there are certain general methods of guarding against attack that may be briefly referred to now.

Using the term in its widest sense **good cultivation** will be found to be the best protection that the farmer or gardener can offer his crops against the ravages of insects. Anything that interferes with the growth or health of plants is indirectly, and sometimes directly, favourable to the attack of insects. **Insufficient fertility** in the soil, **stagnant water, poor seed, bad tilth, abundant weeds, unseasonable sowing, a crop unsuitable to the situation,** are one and all factors unfavourable to the growth of plants, and therefore indirectly favourable to the attack of their enemies. Weak plants, especially in their early stages, are speedily crippled, if not entirely consumed, by the attack of a few insects, whereas robust plants, because of their greater vigour and larger volume, may lose a few leaves and be little the worse. It frequently happens, too, that the dangerous stage in a plant's life does not extend beyond the first few weeks or, it may be, days of its existence, and if it has sufficient vigour to survive this fateful period its future success is practically assured. The Turnip Flea Beetle, for instance, is able to annihilate a crop only in its earliest stage; when once the plants have got beyond the seed-leaf stage, and have developed true foliage leaves—got into "the rough leaf" as it is called—they are practically safe, so far at least as this pest is concerned.

But not only do the presence of weeds and the

absence of a good tilth—in other words the presence of abundant clods—indirectly favour the ravages of insects in the way indicated, but they also, in other ways, and more directly, assist these pests in their work of destruction. In spring, for instance, when the fallow fields are destitute of crops the Turnip Flea Beetle is breeding in, and sustaining itself on, Cruciferous weeds, especially charlock, and were it not for such weeds this insect would experience some difficulty in surviving the period that intervenes between the time when it emerges from its winter quarters, and the season when the young turnip plants occupy the ground. And not only do such weeds supply it with nourishment, but they also furnish it with the means of breeding, and there can be no doubt that the turnip fleas that frequently swarm in our fields in the months of May and June represent the progeny of those that came through the winter.

Clods, too, by affording shelter to this and other insects (*e.g.* Surface Caterpillars), directly aid their attack; and all observant cultivators must have noticed how much more abundant insects are amongst clods than where the tilth is fine.

Rearing Larvæ.

The majority of insects attract attention by their ravages during the larval stage, but as their identification in this stage is frequently a matter of difficulty, it becomes necessary to retain them until they have pupated, and ultimately attained the condition of a perfect insect.

Although the attention necessary to attain this object varies, to some extent, with the species of insect and also with the species of food

plant, the general mode of procedure is as follows. A larva, we will suppose, is found feeding upon leaves, and it is determined to rear the imago. The larva is carefully removed to a pill or other small clean box, and a portion of the leaf is put in beside it. This bit of leaf affords food to the insect, if it be disposed to feed, diminishes the jarring which it might otherwise experience on the journey home, and prevents its becoming dry and parched. If it is intended to keep the insect confined in this way for a couple of days or so, the box should be of zinc or tin, with a perforated lid, or a bottle with a ventilated cork may be used. Although a matchbox in which to confine an insect may have to be used at a pinch, such a receptacle does not always prove satisfactory, on account of the traces of phosphorus that are not unfrequently present inside. Having reached home with the "find" a somewhat more capacious chamber must be provided for its reception. Special breeding cages, with ventilated sides, and an arrangement for holding a small water-bottle, are sold by the dealers in entomological apparatus, but my own experience is that a butter-jar, whose top has been ground on a sandstone slab so that a glass top fits closely upon it, leaves nothing to be desired. Such a jar, preventing, as it does, the rapid evaporation of water, keeps the food fresher than a cage, and is besides usually more easily procured. Sifted soil, moist but not wet, is next placed in the bottom of the jar to the depth of two inches or so. This soil serves a double purpose in that it offers favourable conditions for pupation—should the insect be one that pupates in the soil—and, by securing a saturated atmosphere in the jar, it helps to keep the plant fresh.

As some insects change to pupæ in a cocoon of

wood chips, or by attaching themselves to a wooden object, it is also well to place a piece of old wood in the jar, leaning against the side.

A single fresh leaf, if a large one, of the food-plant, or a considerable portion of the plant if thought desirable, is then placed in the jar, and if the leaf or plant-portion is likely to adhere too closely to the soil, and thus get dirtied, a small thorn-branch or other object, may be placed underneath to raise it somewhat above the bottom. The larva is next carefully transferred to the food-plant in the jar, and the glass plate is placed in position on the top.

The insect should be inspected daily, and as often as the food is exhausted, or appears unpalatable, it must be renewed. In the course of time—usually in about a couple of weeks, but depending on the species, and on the state of development of the insect at the time of capture—the larva changes into a pupa, and as a close jar is apt to induce a growth of mould it is well to remove the pupa and place it on some moist soil in a jelly-pot, covering the top with a piece of muslin. Many insects emerge from the pupal condition in the course of a few weeks, and in their case the pupa requires no further attention after being placed in its new quarters. Others, however, pass the winter as pupæ, and these require to be inspected periodically to see that the soil is kept appreciably moist. The receptacle in which they are kept over winter may be placed outside, or kept in a heated room, and whereas, in the latter case, the appearance of the imago will be accelerated, its emergence will not quite coincide with the appearance of similar insects out of doors.

The preservation of imagines by "setting," and of larvæ by blowing, or immersion in some fluid, are subjects that do not fall within the scope of this

work. Information on these and kindred subjects may be obtained in any small book on practical entomology.[1]

The Classification of Insects.

Although any detailed discussion of the many systems of classification proposed by entomologists would be entirely out of place in this book, the subject cannot altogether be ignored.

Insects belong to the **Type Arthropoda**, the classes of which possess the following characteristics :—Feet jointed, body segmented, and bilaterally symmetrical, bearing at least three pairs of ventral jointed appendages (legs) ; the whole creature being enveloped in a rigid chitinous covering.

The Type Arthropoda is subdivided into four classes, which are thus arranged and distinguished :—

Class I. Crustacea ; two pairs of antennæ (feelers) ; usually more than four pairs of legs ; jointed appendages on the abdomen ; head and breast fused together into a single region (the cephalothorax) ; usually live in water and breathe by gills (*e.g.* crabs and lobsters).

Class II. Arachnoidea ; no true antennæ ; four pairs of legs ; fusion of head and breast into a cephalothorax ; no wings ; generally breathe by tracheæ (*e.g.* mites, spiders, ticks, and scorpions).

Class III. Myriapoda ; one pair of antennæ ; one or two pairs of legs on most segments of the body ; head distinct from breast ; no perceptible difference between thorax and abdomen ; no wings ; breathe by tracheæ (*e.g.* centipedes and millepedes).

Class IV. Insecta ; one pair of antennæ ; three pairs of legs ; segments grouped in three distinct regions (head, thorax, and abdomen) ; generally winged ;

[1] *e.g.* Green's *Insect Hunter's Companion.*

abdomen usually without appendages; breathe by tracheæ; usually undergo distinct metamorphoses (True Insects).

The only member of the first class that directly affects cultivators, whether of forest, field, or garden crops, is the wood-louse (called "The Slater" in Scotland), but it is practically of no economic importance. Several members of the second and third classes are of more interest to cultivators and stock-breeders (*e.g.* the "Red Spider," the minute parasites that produce scab and mange in animals, the ticks, millepedes, &c.), but as they are not insects, in the scientific sense of the word, they will be dealt with in an appendix.

It is the members of the fourth class, therefore, that will now chiefly engage our attention, and these have been arranged in a number of orders which are based upon peculiarities in respect of:—

(1) **The Mouth**—whether adapted for biting or sucking; (2) **the relationship of the prothorax to the mesothorax**—whether firmly fused or freely movable; (3) **the wings** whether two pairs, one pair, or none, and whether horny, pergamentous, membranous, or scaly; whether with veins abundant or scarce, straight or reticulate; and (4) the **Metamorphosis**—whether complete or incomplete.

According to these various characters insects may be grouped in seven orders:—

A. Insects with complete metamorphosis.

I. Mouth biting, or adapted both for biting and sucking.

(*a*) Prothorax free.

(1) Fore-wings transformed into horny covers (elytra); hind-wings membranous, occasionally absent and then the insect is incapable of flight; mouth adapted for biting—**Coleoptera** (beetles).

(2) Both pairs of wings alike; veins frequently much netted, sometimes obscured by scales; mouth usually adapted for biting, occasionally also for sucking—**Neuroptera** (*e.g.*, the caddis flies).

(*b*) Prothorax fused, at least along the dorsal margin, with the mesothorax; two pairs of membranous, rather sparsely veined wings, occasionally none; mouth adapted both for biting and sucking—**Hymenoptera** (*e.g.*, bees, ants, sawflies, ichneumons &c.).

II. Mouth sucking, prothorax fused with the mesothorax.

(1) The fore pair of wings only present, the hind pair represented by two knob-like bodies (halteres or poisers), wings occasionally absent—**Diptera** (flies, midges, and fleas).

(2) Two pairs of wings, usually scaly, occasionally none in the female—**Lepidoptera** (butterflies and moths).

B. Insects with incomplete metamorphosis and free prothorax.

I. Mouth biting; fore-wings straight, narrow, and frequently pergamentous—**Orthoptera** (*e.g.*, crickets, grasshoppers, locusts, dragon flies, Mayflies, cockroaches, earwigs).

II. Mouth sucking, in the form of a jointed rostrum, normally two pairs of wings, with scanty venation, but the wings may be imperfectly developed, or altogether absent—**Rhynchota** (*e.g.*, lice, scale insects, Green Flies, bugs).

Apart from wingless examples, the various orders can scarcely be confused with each other, although occasionally a superficial resemblance exists between certain of them. Thus, those members of the order Orthoptera which possess leathery, pergamentous, or

chitinous fore-wings bear a considerable resemblance to Coleoptera, from which, however, they may be distinguished by the fact that the fore-wings (elytra) of the latter order, with scarcely an exception (Meloë), come together in a straight line and constitute the dorsal suture, whereas those of Orthoptera usually overlap to a greater or less extent.

The earwigs constitute the only Orthopterous family whose fore-wings do not overlap, but in their case the abdominal caudal forceps at once prevents confusion, there being no example of a beetle possessing abdominal appendages of any sort. The presence of caudal appendages (setæ, forceps, claspers, &c.) in Orthoptera is an almost constant feature, so that even when both pairs of wings are membranous they can hardly be mistaken for any Hymenopterous insect, which, otherwise, they may resemble rather closely, although the venation of the wings is fundamentally different.

Confusion between Orthoptera and Neuroptera is prevented to a large extent by the fact that the tarsi of the former are usually only three-jointed, whereas in the case of the latter they have always five joints. The antennæ of those representatives of Orthoptera which are possessed of two pairs of transparent wings are also shorter and more bristle-like than is the case with Neuroptera.

In the classification adopted here the family of the Mayflies, &c., is placed in the order Orthoptera, instead of amongst the Neuroptera, as is often done, it being felt that the ametabolic character of these insects precludes their being classed with others whose metamorphosis is complete. This is the course usually adopted by the continental school of entomologists, though Erichson gets out of the difficulty by creating a new order (Pseudoneuroptera).

Having dealt as fully as space will permit with the general structure and biology of insects, we may now proceed to a more detailed study of those species which are sufficiently numerous and injurious to constitute a standing menace to the farmer or vegetable gardener. In doing so it is proposed to group the insects under the heading of the family of crop-plant that they most affect, and afterwards to look at the few zoophagous insects that prey on domesticated animals. It is believed that in a small text-book on agricultural entomology this plan will suit better than the alternative one of taking up the orders of insects one by one, and thus of having references to the same crop occurring at many different places. In grouping injurious insects according to the food-plants that they most affect, it is not to be supposed that such plants serve exclusively as the food of the insects discussed. In many cases this is so, but in others the food of the insects is of a much more varied character. Thus the insects that destroy pastures are dealt with under the Section Gramineæ, because the plants that constitute the complex herbage of a pasture are for the most part grasses. It does not follow, however, that the pests of our pastures confine their ravages entirely to grasses. On the contrary many of them attack clover, sainfoin, lucerne, burnet, &c., as well, though their food is essentially graminaceous in character.

Under the heading of the various natural divisions of crops the injurious insects are arranged according to the order to which they belong—Coleoptera, Diptera, Hymenoptera, Lepidoptera, Orthoptera, Rhynchota. This arrangement is alphabetical, and, to a certain extent, in accordance with the economic importance of the several orders. The more impor-

tant species are also accorded priority of position under the heading of their order. Where an insect is of first-rate economic importance, or where its identification is a matter of difficulty, illustrations have been introduced, but in other cases the textual description alone will be relied upon. In order to economise space the sign, ♂, will be used to indicate the male, and, ♀, the female sex, two signs (*e.g.*, ♀♀) indicating plurality of the sex concerned.

The general measures of prevention (p. 30) and natural checks (p. 24) having already been discussed, we shall only have to enumerate special preventive and remedial measures in dealing with the various insects.

INSECTS INJURIOUS TO PLANTS OF THE NAT. ORDER GRAMINEÆ, INCLUDING CEREALS, HAY, AND PASTURE.

Coleoptera.

ELATERIDÆ (SKIP JACKS, CLICK BEETLES, OR WIREWORMS).—As these insects belong to a variety of species they have been included under their family name.

Identification.—All the Elateridæ have the following characters (Fig. 11):—Feet five-jointed, elytra

FIG. 11.—Click beetle (nat. size and mag.) and wireworm. To the right a potato attacked by wireworms.

rather narrow and gradually tapering to the apex. When laid on their back they are capable of jerking themselves into the air and of falling on their feet, hence the name Elateridæ or Skip Jacks; and in doing

so they emit a clicking sound, which has given rise to the other popular name of Click Beetles.

The genus that contains the most destructive members is *Agriotes*, which is distinguished as follows:—Head projecting but little beyond the thorax; antennæ usually eleven-jointed, filiform or serrated; the second, third, and fourth joints approximately of equal length; thorax at least as long as broad. The larvæ possess strong biting jaws which, with the head, project straight forward; three-jointed antennæ; three pairs of short feet; cylindrical or flattish yellowish body, furnished with hard chitinous scales and scanty hairs. The grubs are usually about $\frac{3}{4}''$ long, and their appearance and toughness have earned for them the name of wireworms. The pupa is yellowish-white in colour, and is contained in an earthen cell fairly deep in the soil.

AGRIOTES (*Elater*) LINEATUS, L. (*segetis Bjerk.*), the most typical, and, in many places, the commonest species, has an imago sparsely supplied with hairs; the feet and antennæ are yellowish-red, and the elytra are traversed by rows of punctures and by alternating paler and darker lines. Length, a little over $\frac{1}{3}''$. The larva, which is about an inch long when full grown, is semi-cylindrical, and brownish-yellow in colour. The last segment bears a few hairs, is broadest near the middle, and terminates in a short, dark-brown prolongation. Near its anterior dorsal margin are two dark, stigmatic marks. (The last segment of certain other wireworms is bifurcated.)

Life History.—The imagines appear in autumn and hibernate. In spring the ♀ lays her eggs on or near the roots of the most varied kinds of plants, and in a month the larvæ appear. During the first summer they do but little damage, and on the

approach of winter they seek the deeper layers of the soil. In the succeeding season they feed voraciously from April till October, and again hibernate. In the early part of the third season they are again at work, but about the month of July they construct a chamber in the soil and change into pupæ, emerging as imagines about a month later. The imagines feed upon flowers and leaves, but seldom do any appreciable damage. It is not till the following spring that copulation and oviposition takes place. The generation is thus a triennial one. Wireworms are absolutely polyphagous, feeding upon dead and living vegetable—to some extent animal—matter of all sorts, such as cereals, grasses, turnips, potatoes, young trees, &c. They are usually associated, however, with damage to cereals, and are the cause of the condition of things known as "wormed corn."

Preventive and Remedial Measures.—

1. Close grazing of a pasture before breaking up. Wireworms are most destructive to cereals after grass (so-called ley or lea corn), and ♀♀ are specially attracted to rough grass fields for the purpose of laying their eggs.

2. Gas-lime ($1\frac{1}{2}$–$2\frac{1}{2}$ tons per acre) before ploughing. This is much more effective than common lime or salt.

3. Paring and burning. Under the present conditions of English farming this is only applicable in garden practice.

4. Green manuring with white mustard. Only of local or restricted application.

5. Slices of potatoes distributed over garden ground—best placed underneath the surface, and marked by a wooden pin—will attract numbers of wireworms, which must be collected and destroyed every morning.

6. Shallow covering of the seed. The result is that the plants have their roots disposed nearer the surface of the ground, and these, being more abundant and compact, escape better.

7. Harrowing and hard rolling—especially with a Cambridge roller—in spring, after the plants are up, is invariably beneficial to a greater or less extent.

8. Top-dressing with nitrate of soda (1–1½ cwt. per acre) stimulates growth and enables the plants better to withstand attack.

9. Powdered rape cake applied before sowing, is distasteful to the wireworm, and is valuable as a manure.

MELOLONTHA VULGARIS, Fab. (THE COCKCHAFER OR MAY BUG).—*Identification* (Fig. 12).—Imago about 1″ long, thorax black; elytra, reddish-brown, traversed

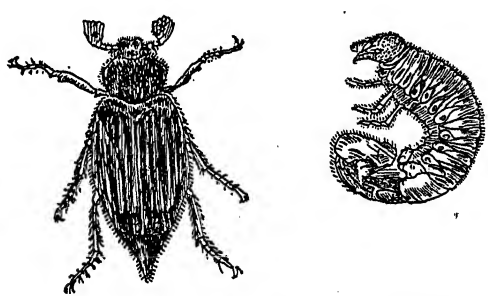


FIG. 12.—Cockchafer and larva, slightly mag. (After Hess.)

longitudinally by five raised lines, interspaces finely pubescent; legs and feet reddish-brown, the latter five-jointed. Antennæ ten-jointed, the last seven of which in the ♂ and six in the ♀ have prominent lateral processes (lamellæ); abdomen with five white

triangular marks along each side; apex of abdomen ending in a prolongation not covered by the elytra.

Larva, when full grown, over an inch long, dingy white in colour, sparsely haired, with three pairs of four-jointed legs, body semicircular, distended and darker behind; head brown, with strong, biting jaws, and four-jointed antennæ.

Life History.—The ♀ lays her eggs about 3″ beneath the surface of the ground in May or June, and four to six weeks later the larvæ appear. For the first year these do but little harm, but during the second, third, and fourth seasons they feed upon the roots of all kinds of plants, and the damage which they cause is, collectively, greater than can be ascribed to any other European insect. During winter they retire to the deeper layers of the soil, and in August or September of the fourth season they change into brown pupæ a considerable distance from the surface of the ground. The pupal stage lasts about two months, and in the end of October or early in November the imago appears and at once proceeds to hibernate. In the following spring the perfect insects feed for the most part on the leaves of trees where they do comparatively little harm, and the ♀♀ oviposit in May or June. The generation is thus quadrennial. Common in Ireland and the south and west of England, becoming scarce further north. The greatest amount of damage is done in gardens and nurseries.

Preventive and Remedial Measures.—The measures numbered 1, 2, 3, 6, 7, 8, under the Wireworms, are also applicable in dealing with the Cockchafer.

In France, Germany, and other European countries many special eradicative measures have been put in force against this insect, but nearly all without material effect. At present the most successful method of dealing with the pest is to collect the imagines during

the so-called "Cockchafer years," which in many districts correspond with the leap years. The work is done for the most part by women and children, and is paid for by contract at the rate of 6*d.* to 1*s.* per bushel. The insect may also be dealt with, on a small scale, by—

1. Distributing sods with the grassy side downwards at short intervals over the affected area. The grubs collect beneath these sods, when they may be removed and destroyed.

2. Preparing heaps of humus mixed with swine manure. The eggs are deposited in such places in large numbers, and the whole may afterwards be destroyed.

PHYLLOPERTHA HORTICOLA, L. (THE SMALLER JUNE BUG, OR COCH-Y-BONDHU).—*Identification.*—Length about $\frac{1}{3}$"; feet five-jointed; antennæ nine-jointed; club consists of three lamellæ which are much smaller than in the Cockchafer; elytra yellowish-red and punctured; head and thorax greenish or bluish-black with a metallic lustre; the whole body thickly covered with longish light-brown woolly hairs. The larva closely resembles that of the Cockchafer, but is much smaller.

Life History.—The beetles appear in May and June, when they feed upon the leaves and flowers of trees and shrubs, sometimes doing considerable damage to roses. The eggs are laid near the roots of many kinds of plants, but especially in grass fields. The grubs appear in about a month and live on the roots. Having hibernated they change to pupæ in the spring of the following year.

Most damage is done to old grass land, including mountain pasture. The grass turns brown and dies in smaller or larger patches, and as practically all the roots have been severed about two inches beneath

the surface of the ground the turf may be rolled off in large sheets, when the white curved grubs will be found in great abundance underneath. Very common all over the country.

Preventive and Remedial Measures:—

1. The imagines may be collected in June by placing a sheet beneath the bushes on which they are feeding, and then beating them off with a stick.

2. In grass fields gas lime (three or four tons per acre) applied fairly fresh is the best remedy.

RHIZOTROGUS SOLSTITIALIS, L. (THE JUNE BUG).—*Identification.*—Length about $\frac{3}{5}$"; elytra pale brown, each traversed by four longitudinal raised lines; apex of abdomen not covered by elytra; head and thorax much darker than elytra; antennæ nine-jointed, ending in a club of three lamellæ; feet five-jointed. The whole body is densely covered with brown hairs which are scarcest on the elytra. Resembles the Cockchafer, from which, however, it is readily distinguished by its smaller size, paler colour, less pointed abdomen, and by the difference in the number of joints in the antennæ and club. The larvæ of the two insects are also very similar in appearance, but that of R. solstitialis is smaller, and yellower, while the sac-like distension at the end of its body is not so pronounced.

Life History.—Towards the end of June, and in July, the ♀ lays her eggs, for the most part in grass fields. These hatch in about a month and the larvæ live on the roots of grass, cereals, &c. Having hibernated deep in the soil the larvæ pupate in May, and a month later the imagines appear.

Preventive and Remedial Measures as in the case of Phyllopertha horticola.

CALANDRA GRANARIA, L. (THE CORN WEEVIL).—*Identification.*—This is a representative of the great

family of the Weevils (Curculionidæ), all of which possess apparently four-jointed feet, and a more or less prominent rostrum or snout, which usually bears geniculate clubbed antennæ. The grubs, which are footless, are slightly bent, and are furnished with a short brown head. C. granaria is characterised as follows:—Length, excluding the rostrum, about $\frac{1}{7}''$; colour brownish-black; rostrum slightly curved; antennæ rusty, with a six-jointed funiculus and an unjointed club; thorax punctated, nearly as long as the abdomen, contracted in front; elytra strongly striated, not quite covering the abdomen, almost hairless; tarsi rusty.

Life History.—This weevil was imported into Britain from the East in foreign grain, and although it breeds freely in granaries and the like it is seldom met with out of doors. In spring or early summer the ♀ makes a hole with her rostrum in the grains of cereals, in which she deposits her eggs. About 150 eggs are thus laid, but only one in each grain. These hatch out in a fortnight or three weeks, and the white footless grub feeds on the contents, ultimately pupating in the grain. A fortnight later the imagines appear and lay their eggs as before, so that in autumn another brood of beetles is produced. These hibernate in crevices or amongst the grain, and breed in the following spring or early summer. Double generation.

Preventive and Remedial Measures.—

1. Good ventilation of granaries, and the admission of plenty of air, especially during frosty weather.
2. Frequent turning of grain that is being stored for a prolonged period.
3. In spring and autumn especially, a sheep's skin laid on a heap of infested grain will attract many beetles, which may then be shaken into water.

4. All cracks and crevices in the floors and walls of infested granaries must be closed, and the walls and woodwork should be frequently whitewashed.

Diptera.

CECIDOMYIA DESTRUCTOR, Say (THE HESSIAN FLY).—*Identification* (Fig. 13).—Length about $\frac{1}{8}''$; black with the exception of certain marks on the ventral surface of the abdomen, the points of contact of the abdominal segments, and a line along the back, which are red. Shortly after death the red colour disappears. Wings thickly covered with short grey hairs; poisers pale brown, rather prominent; antennæ usually fifteen-jointed, one-third the length of the body, beset with brownish hairs. The body is covered with dark hairs.

Eggs cylindrical, pale red.

Larva about $\frac{1}{5}''$ long, mouth parts very rudimentary, footless, pale red when young, becoming yellowish-white, and transparent later on.

Pupa about $\frac{1}{6}''$ long, of a chestnut colour, closely resembling a somewhat narrow flax-seed.

Life History.—The insect acquired its popular name from the belief that it reached America in 1778, in the straw of Hessian mercenary troops. It was unknown in England till the summer of 1886, when pupæ, &c., were sent to Miss Ormerod from Hertfordshire. The imago appears on warm evenings in early summer (May), and the ♀ lays about ninety eggs, depositing these singly or in pairs, between the veins near the base of a leaf-blade of wheat, barley, or rye (not oats). Within ten days the maggots appear and crawl back between the leaf sheath and the stem till they reach a knot where they establish themselves, and proceed to extract the juices. In consequence of their attack the stems

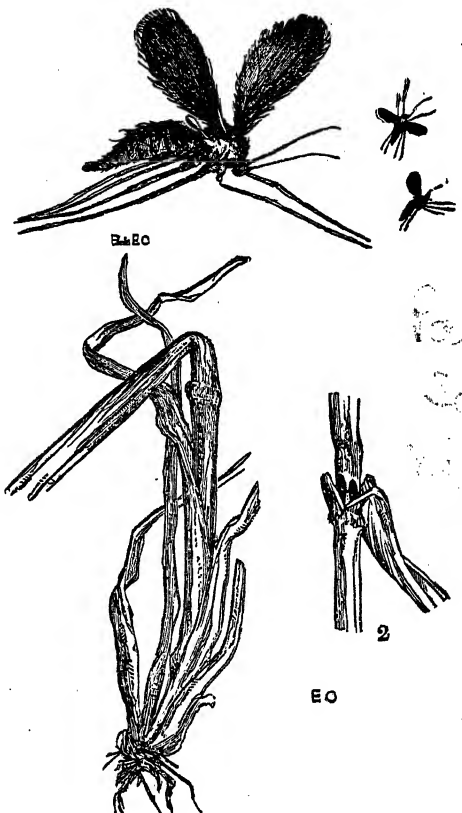


FIG. 13.—The Hessian Fly. Above, the imago (mag. and nat. size); below, the stem of a cereal bent over in consequence of attack; to the right the pupæ at the base of a leaf-sheath. (After Ormerod.)

become enfeebled and bend, or even break, over when affected by wind or heavy rain (Fig. 13), and this

condition usually attracts attention to the presence of the insect. When about two months old the maggot pupates in the place where it has been feeding, and a fortnight later the fly appears, for the most part in July and August. These flies lay their eggs on winter wheat, and the maggots pass the winter either in the plants or underneath the surface of the ground. In the following spring they pupate, and the imago appears in early summer.

This represents a double generation, but if the weather is unfavourable there is no autumn swarm of flies, maturity not being reached till spring. In this case, therefore, there is only one brood annually.

The damage consists of the breaking or bending of the straw (Fig. 13), the interference with the normal formation of grain, and the death of the plants, especially winter wheat.

Preventive and Remedial Measures.—

1. The stubble of affected fields should be quickly ploughed with a deep furrow, so that the pupæ located near the base of the stem may be buried at such a depth that the flies will be unable to reach the surface of the ground. A skim coulter greatly assists in the attainment of this object.

2. Burning the stubble, where practicable, will result in the destruction of most pupæ.

3. If the sowing of winter wheat is delayed till the end of October or November the autumn swarm of flies will be unable to utilise the plants for oviposition.

4. The screenings from the mill should be burned or boiled; treading them down in cattle courts, or giving them uncooked to stock, is not a sufficient safeguard.

5. If attack is to be feared, some variety of cereal characterised by stoutness of stem should be culti-

vated. Liberal manuring will also strengthen the straw and reduce the amount of breaking or bending under attack.

CECIDOMYIA TRITICI, Kirby (THE WHEAT MIDGE OR RED MAGGOT).—*Identification* (Fig. 14).—Both sexes are lemon-coloured, except the antennæ and eyes, which are black, and the legs, which are dingy yellow. The

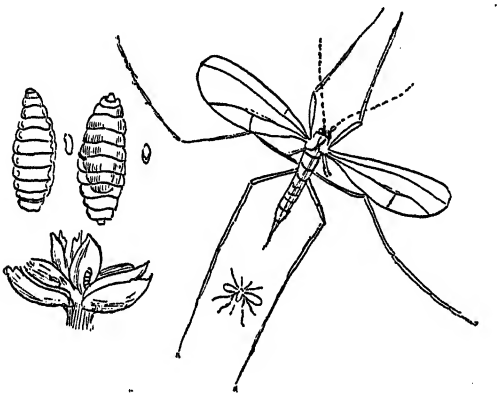


FIG. 14.—A ♀ Wheat Midge and larvæ (nat. size and mag.). A spikelet of wheat is also shown with the maggots amongst the chaff. (After Curtis.)

♀ has fourteen-jointed antennæ about three-quarters as long as the body. Her total length is about $\frac{1}{16}''$, exclusive of the ovipositor, which, when extended, is double the length of the body. The ♂ has twenty-six-jointed antennæ about one and a half times as long as the body. Total length of male about $\frac{1}{25}''$.

Eggs four times longer than broad, transparent.

Larva about $\frac{1}{8}''$ long, of a pale or deeper yellow colour, footless, ending abruptly behind, tapering to

the rudimentary head in front which bears a pair of tiny two-jointed antennæ.

Pupa, lemon-coloured with some brown markings.

Life History.—The ♀ lays her eggs on summer evenings (June and July) in the flowers of wheat, rye, and certain grasses, but not to any great extent, if at all, in oats or barley. Usually three to twelve are laid in a single flower, and the maggots, which appear in about a week, live on the ovary and grain and destroy the seed. If the attack is a bad one the whole spike may be destroyed, in other cases only a proportion of the grains fails to reach maturity. In three weeks the maggots creep down into the soil where they hibernate, and pupate in the following spring, the imago appearing in summer.

The damage consists in the destruction or incomplete development of the grain.

Preventive and Remedial Measures.—

1. Deep ploughing of the stubble so that the midges shall be unable to reach the surface.

2. Burning or boiling chaff and screenings containing the maggots or pupæ.

OSCINIS FRIT, L. (THE FRIT FLY).—*Identification.*—Imago $\frac{1}{8}''$–$\frac{1}{12}''$ long; body and legs black; feet yellow; wings gray when alive, transparent when dead; poisers yellowish when alive, white when dead.

Larva $\frac{1}{6}''$–$\frac{1}{8}''$ long, whitish, two hooks at anterior, and two stigmatic tubercles at posterior extremity.

Pupa pale brown, $\frac{1}{12}''$ long.

Life History.—The ♀ lays her eggs in April or May on the underside of a cereal leaf. The larvæ appear in a few days and eat into the centre of the plant, destroying or crippling the young leaves or shoot. In a month or so the maggot pupates on or near the outside of the plant, and a week or ten days later the fly appears. These flies proceed to lay

their eggs, for the most part, on grass, because by this time the cereals are too far advanced in growth. Another swarm of flies appears in September, and these utilise winter wheat for purposes of oviposition, and finally pass the winter as pupæ. There are thus three generations annually, though unfavourable weather may limit the generations to two.

Preventive and Remedial Measures.—

1. Early sowing, so that the plants may be beyond the stage of attack when the flies appear.

2. Liberal manuring to force growth beyond the dangerous stage.

3. If it is necessary to plough up a crop, the plants and surface soil should be buried deeply by means of a skim coulter in order that the flies may be unable to reach the surface.

CHLOROPS TÆNIOPUS, Mg. (THE GOUT, OR RIBBON-FOOTED CORN FLY).—*Identification* (Fig. 15)—Length $\frac{1}{6}''$–$\frac{1}{8}''$; the prevailing colour is yellow, but the antennæ, the eyes, a mark on the forehead, three longitudinal lines on the thorax, the forefeet, and two small patches on the ventral surface of the thorax are black. The wings are transparent, and the poisers white.

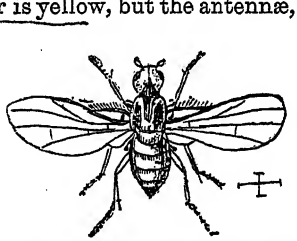


FIG. 15. — The Gout Fly, mag. (After Bos.)

The Larva is about $\frac{1}{5}''$ long, yellowish-white, and footless, with two stigmatic tubercles on the truncated posterior extremity, while the two mouth hooks are very inconspicuous.

The Pupa is oval, pale brown, and somewhat compressed.

Life History.—The ♀ lays her eggs in May or

June, singly or in pairs, at the base of the blade of a leaf of wheat, barley, oats, rye, or grass, at a time when the spike is still enveloped in the sheathing leaves. The maggots hatch out in a week or so and bore into the stalk, eating their way down to the first knot. The gallery which the maggots make in this way is two to four inches long, and does not extend much if at all beneath the epidermis. On account of the attack the spike remains contracted, and swells considerably within the enveloping leaf sheaths, imparting the characteristic gouty or distended appearance to the plant. The maggot ultimately pupates in the plant, and the imagines appear in July and August. These lay their eggs on various grasses, in which the larvæ hibernate, and from which the early brood of flies appears in the following summer.

The damage consists in the complete or partial suppression of the development of the spikes, and the production of imperfect grains.

Preventive and Remedial Measures.—

1. Early sowing of spring corn, so that the plants may be well advanced in growth when the flies appear.

2. Stimulating dressings, to force growth. If the spikes have emerged from the sheath by the time the fly appears they are useless for oviposition, and even if strong plants are attacked their vigorous growth will largely minimise the effects of attack.

The Genus Tipula (The Crane Flies, Daddy Long Legs, &c.).—This genus contains at least thirty-one British species, many of whose larvæ are more or less destructive to cereals, grass, and other crops. The generic characters are:—Legs strikingly long, antennæ thirteen-jointed, ocelli absent, head prolonged into a prominent proboscis, wings long and narrow, abdomen of eight segments, ♀ with a long ovipositor. The

larvæ ("Leather Jackets") are cylindrical and footless, but possess retractile heads, and live on dead and living vegetable matter, being very common in rotten wood. The commonest species is Tipula oleraceæ, L., to which the following remarks more especially apply (Fig. 16).

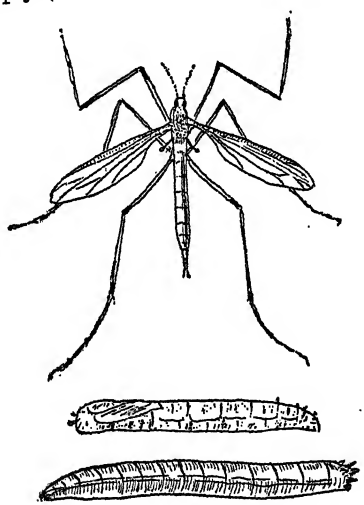


Fig. 16.—Daddy Long Legs, with the larva below, and the pupa in the middle (nat. size).

Identification.—Length about 1"; colour, grayish yellow; antennæ, yellow towards the base; thorax, markedly convex on upper surface, which is traversed by eight more or less distinct brown lines; wings, slightly smoky with a reddish anterior margin.

The Larva, which exceeds an inch in length, is cylindrical, grayish red, much wrinkled, sparingly

covered with bristles and tubercles; head, retractile into thoracic segments, black, provided with strong biting jaws (this is exceptional in Dipterous larvæ) and a pair of two-jointed antennæ; last abdominal segment excavated, the depression, which is surrounded by six tubercles, contains a pair of black stigmata.

The Pupa is cylindrical, pale brown, truncated behind, and provided on the posterior segments with stout spines, by means of which it forces its way to the surface of the ground shortly before the imago appears.

Life History.—The imagines are chiefly abundant during August and September, at which time the ♀ lays 100–200 eggs singly on, or just under, the surface of grass fields. In about a fortnight the larvæ appear, and at first feed upon humus, but the following spring they attack the roots of all kinds of plants, especially the mixed herbage of grass fields, or corn that may be cultivated after grass (lea corn). During summer pupation takes place, and three weeks later the perfect insect appears.

Preventive and Remedial Measures.—

1. Drainage, the fly preferring damp land.

2. Close pasturing in autumn, rough herbage being more utilised for purposes of oviposition than bare ground.

3. Ploughing grass land so early in autumn that the work is finished before egg-laying commences. This, however, is seldom practicable.

4. Dressing with gas lime (two to four tons per acre) in early autumn. If this be done soon enough it prevents eggs being laid; if eggs have already been laid it destroys them or the larvæ.

5. Top-dressing affected crops with forcing manures.

6. Harrowing and rolling, by killing the grubs or exposing them to the attack of birds, are usually followed by good results.

Hymenoptera.

CEPHUS PYGMÆUS, L. (THE CORN SAW FLY).—*Identification* (Fig. 17).—The Imago is about ¼″ long, shining black, except the mouth parts, a mark on the side of the third, and a band round the fourth and sixth, and partly the seventh and last segments of the abdomen, which are yellow. The ♂ has also all legs more or less yellow, whereas the hind legs of the ♀ are black. Antennæ nearly as long as the abdomen, somewhat thickened towards the apex. Wings long and rather narrow, with nearly black veins.

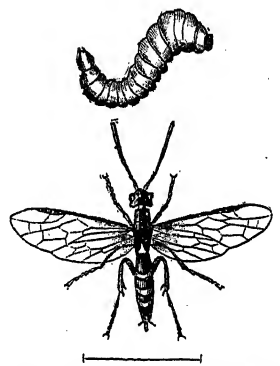


FIG. 17.—The Corn Saw Fly (mag.).

Larva, yellowish-white, footless and hairless, gradually tapering towards the posterior extremity, segmentation very prominent, head brownish-yellow. The single spur on the anterior tibiæ, and the more elongated prothorax of the imago, besides the absence of legs in the larva, serve to separate Cephus from the true Saw Flies (Tenthredinidæ) and to place it amongst the wood wasps (Siricidæ).

Life History.—In early summer the ♀ by means of her ovipositor pierces the stems of cereals—especially wheat—and deposits one egg in each (from

twelve to fifteen in all). In about ten days the larva appears and eats down the centre of the stalk, piercing the knots, and ultimately hibernating in a cocoon near the base of the plant, that is to say, in what eventually becomes the stubble. Next spring pupation takes place, and a fortnight later the imago appears. The damage consists in the formation of imperfect grain as a consequence of the enfeeblement of the stem.

Preventive and Remedial Measures.—

1. Leaving a very short stubble, so that most larvæ will be removed in the straw, in which they are likely to be subsequently destroyed.

2. Ploughing the stubble with a skim coulter so as to bury the larvæ in the bottom of the furrow, and thus prevent the exit of the imago.

3. Burning the stubble, if that be practicable.

Lepidoptera.

CHARÆAS (NOCTUA) GRAMINIS, L. (THE ANTLER MOTH, OR GRASS MOTH).—*Identification* (Fig. 18).—

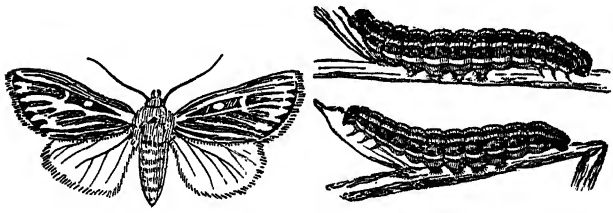


FIG. 18.—The Antler Moth and larvæ, nat. size. (After Newman.)

Length $\frac{3}{4}$", wing-stretch about $1\frac{1}{4}$". Antennæ of ♂ serrated, of ♀, with two bristles on each joint. Thorax covered with fine smooth hairs. Fore-wings brownish-red, frequently tinged with green, with a pale reni-

form and orbicular mark near the middle of each, and with the veins white and ramifying like a stag's antlers (hence the name). Hind-wings yellowish-gray, lightest at the base, fringed with whitish-yellow hairs.

The Larva about $1\frac{1}{2}''$ long, sixteen feet, greenish, grayish, or dark brown, pale dorsal line, narrow white line on each side of the body with a black crescent-shaped mark above it on each segment, head pale with two dark brown lines down the front; the whole shining as though varnished.

Pupa lustrous brown, with two hooks at the tail.

Life History.—The eggs—about 200 in all—are laid in July and August on the roots and lower parts of grasses. The caterpillars appear in about three weeks and feed during the night on grass, biting through the stems, and leaving the upper parts of the plants unconsumed. The larvæ hibernate under stones, &c., and next spring and summer they renew their attack, finally pupating in the ground about June.

The damage consists in the destruction of pastures and meadows, especially in hilly districts such as Wales, the north of England, and south of Scotland, where the Antler Moth has frequently been a very serious pest. It has also been known to attack young cereals.

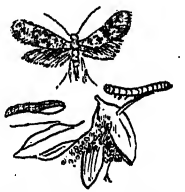


Fig. 19. — The Corn Moth, with larva and pupa, and infested grain, about nat. size. (After Bos.)

Remedial Measure.— Burning the pastures at night in autumn or spring, is the only effective remedy.

Tinea granella, L. (The Corn Moth or Corn Wolf). — *Identification* (Fig. 19). — Wing-stretch about $\frac{1}{2}''$; head and thorax white; fore-wings silvery-

white with numerous dark markings; hind-wings grayish-brown; antennæ blackish.

Larva about $\frac{1}{3}$" long, sixteen feet, dirty white; head and first segment pale brown, very sparingly supplied with hairs.

Pupa brown, wriggles actively when disturbed.

Life History.—In early summer (June) the moth lays her eggs on grain of all kinds stored in granaries, and in a fortnight the larvæ appear. These eat into the grain, but their presence is indicated by their droppings and by the way the grains adhere together by silken threads. In autumn the larvæ cover the whole heap of grain with silken threads, and finally crawl into cracks of the walls, floor, &c., where they construct cocoons in which they hibernate, and finally pupate in spring.

Preventive and Remedial Measures.—

1. Frequent turning of stored grain, especially in early summer.
2. Kiln-drying suspected grain.
3. Vessels of water set out in the granary at night in June will attract many of the moths, which fall in and are drowned.
4. Woodwork should be frequently whitewashed, and cracks filled up.
5. Mixing stored grain with salt tends to ward off attack.

Orthoptera.

THRIPS CEREALIUM, Hal. (CORN THRIPS).—*Identification* (Fig. 20).—Length $\frac{1}{12}$"; ♂ wingless, ♀ with four narrow wings which curve out and leave the hinder part of the abdomen exposed. The fore-wings are horny in texture, the hind-wings being membranous, and both pairs are bordered by a fringe of long hairs. The

feet consist of two joints only, and are provided with small bladder-like swellings instead of claws. Colour dark brown or black, except the feet and certain rings on the abdomen, which are pale yellow.

Fig. 20.—Corn Thrips, much mag. (After Taschenberg.)

Larva, orange yellow with darker markings; six legs.

The genus Thrips is so peculiar in some ways that Haliday placed it in an order by itself (Thysanoptera = Fringe Winged). It is usually now included in the family Physopoda (= Bladder-footed) and the order Orthoptera.

Life History.—The eggs are laid on the leaves and flowers of grasses and cereals in spring. From these the larvæ soon appear, and destroy the grain by sucking the juices. The movements of the imago are very active. Several generations annually, the imago hibernating.

Preventive Measure.—All that can be done to mitigate attack is to plough deep, and thus bury the stubble, with the hibernating insects, so far below the surface that they are likely to be destroyed.

Rhynchota.

Aphis cerealis, Kalt., and Aphis avenæ, Fab. (The Corn and Oat Aphides).—*Identification*—The wingless individuals of A. cerealis are green or reddish-brown; antennæ as long as the body, springing from a short tubercle, first three joints pale brown, the rest black. Length about $\frac{1}{12}$". The winged individuals are reddish-brown, with a green abdomen;

the antennæ are longer than the body, and dark brown in colour. Length as before. This species lives on the ears of cereals and grasses.

The wingless individuals of A. avenæ are $\frac{1}{12}$" long; dark green or brown; antennæ as long as the head and thorax, black, with the exception of the second, third, and fourth joints which are pale brown. The winged individuals have a black head and thorax, the abdomen is green with four black marks on each side. This species lives on the leaves of oats and barley.

Life History.—As the mode of life of Aphides, or Plant Lice, is essentially the same in all cases, a general description may suffice for these and other species subsequently referred to.

Winter is usually passed as an egg from which females are hatched in spring. These reproduce parthenogenetically and viviparously, and in a few days their progeny breed in a like manner. This mode of reproduction goes on during summer—males at this time being absent—but with the approach of colder weather both sexes—usually winged—are represented in the young that are born at that time. Copulation takes place, and the ♀ flies away to lay her eggs which serve to carry the species over the winter, and in spring hatch out in the manner described. During summer most of the Aphides are wingless, but if, owing to the size of the colony, food gets scarce, winged individuals are produced, and these take flight to found new colonies on other plants.

Preventive and Remedial Measures are not practicable in the case of cereal Aphides, which indeed are seldom very destructive, though frequently numerous. The composition of a serviceable insecticide for use on plant lice is given at p. 68.

INSECTS INJURIOUS TO THE NAT. ORDER LEGUMINOSÆ.—Beans, Peas, Clover, &c.

Coleoptera.

Genus Bruchus, L.—This genus contains several species that are destructive to seeds. The generic characters are :—Head, prolonged into a short snout (much less prominent than the proboscis of the weevils); antennæ, straight, eleven-jointed, slightly thickened at the apex; body more convex below than above; elytra, shorter than the abdomen, and consequently leaving the apex exposed; feet, four-jointed; larvæ, footless, closely resembling those of the weevils. The two most important species are **Bruchus granarius, L.**—black, but the femur, tibia, and tarsus of the forelegs and the four basal joints of the antennæ are reddish; prothorax with two white spots in front, and a white blotch behind; elytra with irregular white markings; apex of abdomen, grey; length ¼", lives in beans—and **Bruchus Pisi, L.** (Fig. 21), which closely resembles the former from which, however, it is distinguished by its greater length (⅓"), by only the tibia and tarsus of the forelegs being reddish, and by its living only in peas.

Fig. 21.—Bruchus Pisi, the Pea Beetle, mag. (After Nördlinger.)

Life History.—In both cases the ♀ lays her eggs in the flower, and the larvæ feed upon the cotyledons of the seed. The imago appears in autumn, and passes the winter inside the seed where it develops, and in the following summer it eats its way out—leaving a circular hole (Fig. 22)—and flies to the flowers of its food-plant. The insects are frequently introduced to a field in the seed, and the damage consists in the complete or partial destruction of the cotyledons, and the production of imperfect seeds.

FIG. 22.—A bean from which B. granarius, the Bean Beetle, has escaped. (After Nördlinger.)

Preventive and Remedial Measures.—

1. Immersing the beans or peas in water of a temperature of 125° F. for two hours.

2. The fumes of bisulphide of carbon (1 oz. to 100 lbs. of seed) will kill the insects—even the larvæ—in a few hours. This substance is best applied by hanging cloths saturated with the liquid over the seed in a close box or chamber. Being extremely inflammable, it must be used with caution.

3. Place the beans or peas on a floor and water them with a five per cent. solution of blue vitriol (*i.e.*, 1 lb. of blue vitriol to two gallons of water). One gallon of such solution will suffice for four bushels of seed, which should be turned over with shovels several times to ensure equal distribution.

SITONES (SITONA) LINEATUS, L. (THE PEA WEEVIL).—*Identification* (Fig. 23).—Length about $\frac{1}{5}''$, grayish in colour with alternate yellower lines running down the thorax and elytra; antennæ geniculate, thickened at the apex.

Larva white, footless, with a brown head.

Life History.—The eggs are laid near the base of peas, beans, clover, and many other leguminous

plants, on the roots of which the larvæ feed. The imago feeds on the leaves, the margins being first attacked, and when disturbed it falls to the ground and feigns death.

Fig. 23.—Sitones lineatus, mag. (After Taschenberg.)

The damage consists in the loss of foliage, and the attack is worst when the plants are small and the weather is unfavourable for growth. Many other species of Sitones are also met with on leguminous crops.

Preventive and Remedial Measures.—

1. Abundant manuring and suitable tillage to force growth.

2. Dusting on soot or lime when the leaves are wet.

3. The soap and paraffin solution recommended for the Bean Aphis may be used for the Pea Weevil.

Apion apricans, Herbst (The Pear-shaped Weevil.)—*Identification.*—Length about $\frac{1}{10}$″; black with the exception of the basal joints of the antennæ, the whole of the fore-legs, and the femur of the hind-legs, which are yellowish. The antennæ are straight and attached near the middle of the proboscis. Elytra strongly striated.

Larva dingy white, footless, with a brownish head.

Life History.—The eggs are laid in the flowers of clover in early summer, and the larvæ live upon the seeds, ultimately pupating in the flower heads. There are probably two generations annually.

The damage consists in the destruction of the seeds, and where clover is cultivated for seed great loss may occur.

Besides A. apricans many other species of Apion

are met with on our cultivated plants, in fact this is the largest genus of beetles, with one exception, met with in this country, containing, as it does, some seventy-five species.

Preventive and Remedial Measures.—

1. Arranging the rotation so as to avoid having clover frequently on the same ground.

2. Hand-picking and destruction of infested flowers, these being recognised by premature fading.

Lepidoptera.

GRAPHOLITHA NEBRITANA, Tr. (TORTRIX PISANA; Gn.) (THE PEA MOTH).—*Identification* (Fig. 24).—

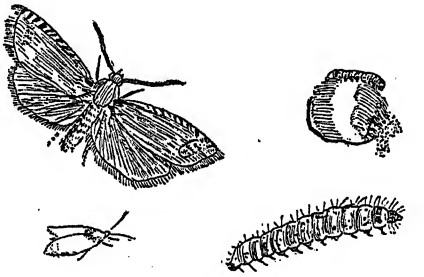


FIG. 24.—The Pea Moth, nat. size and mag. and larva, mag. To the right a damaged pea. (After Curtis.)

Wing-stretch about $\frac{3}{8}''$; fore-wings mouse-coloured, with paler and darker transverse lines along the anterior margin, and with a narrow dark brown marginal line and a distinct fringe; hind-wings darker.

Larva, about $\frac{1}{2}''$ long, sixteen feet, pale green,

head and prothorax brown, body sparingly covered with black tubercles and bristles.

Life History.—The ♀ lays her eggs, usually singly, in the flowers of the pea, and in a fortnight the larvæ bore into the young pods and live upon the seeds. Towards autumn they eat their way out and crawl down to the ground where they hibernate in a cocoon and pupate in the following spring.

Preventive and Remedial Measures.—

1. Destroying such caterpillars as may be found in "wormed" peas.

2. Not leaving peas long ungathered, for it is only when pods have been allowed thoroughly to mature that the larva is sufficiently developed to crawl down to the ground. Where peas are used green the larvæ do not get the chance of escaping to their winter quarters.

3. Burying the surface soil of infested areas deep, to prevent the moths emerging next summer.

Rhynchota.

APHIS FABÆ, Scop. (A. PAPAVERIS, Fab.) (THE BEAN APHIS, COLLIER, OR BLACK DOLPHIN).—*Identification.*—Both the winged and wingless individuals are about $\frac{1}{12}$" long, and for the most part black, the third and fourth segments of the antennæ and the fore-legs being, however, white in the wingless forms.

Life History.—See p. 62. During summer this Aphis lives on the younger leaves and shoots, and on the flower stalks of the bean, poppy, and a variety of other plants. The damage consists in the abstraction of sap, and the consequent crippling of the plants.

Preventive and Remedial Measures.—

1. Lopping off and, if possible, collection and destruction of the upper part of infested beans.

2. Dusting the plants with soot or powdered lime.

3. Dissolve 28 lbs. of soft soap in 28 gallons of boiling water. While still boiling add $12\frac{1}{2}$ pints of paraffin, stirring vigorously. Before using, add soft water till the whole measures 100 gallons. This gives a strength of $\frac{1}{2}$ gill (= a wine-glassful) of paraffin to a gallon of solution, which is as strong as can be used without injury to young leaves. The emulsion may be applied on a large scale by means of a Strawsonizer or other spraying machine, and the above quantities will suffice to dress two acres.

INSECTS INJURIOUS TO THE NAT. ORDER CRUCIFERÆ—TURNIPS, CABBAGES, RAPE, &c.

Coleoptera.

PHYLLOTRETA (HALTICA) NEMORUM, L. (THE TURNIP FLEA-BEETLE OR TURNIP FLY).—*Identification* (Fig. 25) —Length, $\frac{1}{8}$–$\frac{1}{12}$″; black, or blackish-green, or blue, with a broad longitudinal yellow line on each wing cover. The base of the antennæ—which are eleven-jointed—and the legs are brownish-yellow. This insect, like the other members of the family, is capable of making long flea-like leaps—hence one of its popular names.

Larva, $\frac{1}{8}$″ long, six-footed, yellowish-white, body sparingly covered with bristles; head, prothorax, and last segment brown.

FIG. 25.—Turnip Flea-beetle and larva, mag. (After Bos.)

Life History.—The imagines hibernate under all sorts of cover, and in spring the ♀ lays her eggs on the underside of the leaves of crucifers. These hatch in ten days, and the grubs eat into the parenchymatous tissue of the leaves, where they make tortuous galleries whose diameter increases with the growth

in size of the grub. In about a fortnight the larvæ crawl into the soil where they pupate, and ten days later the imago appears. There are several generations annually.

The damage consists in the destruction of the leaves by the beetles, and the excavation of the leaves by the larvæ. The most dangerous stage in the growth of the turnip, or any cruciferous crop, is that between the germination of the seed and the development of the true foliage leaves ("the rough leaf.") At that time the beetles feed upon the cotyledons (seed leaves), and should these be destroyed the young plant must perish. During dry weather—especially sunny days and frosty nights—such as is often experienced in May and June, the young plants make but little growth, and the turnip flea-beetles being under such circumstances very active, get the upper hand of the crop, and frequently necessitate re-sowing over wide areas.

(*Note.*—In many—perhaps most?—parts of the country the "turnip fly" is not P. nemorum but P. undulata, Kuts., the latter resembling the former in nearly every respect, but from which it is distinguished by its smaller size and nearly black legs.)

Preventive and Remedial Measures.—

1. Careful eradication of all cruciferous weeds (Charlock, Shepherd's Purse, &c.), for it is on these that the beetles feed and breed in spring and early summer before the young turnips are above ground.

2. Good tilth to secure rapid germination of the seed and satisfactory growth of the young plants. Bad tilth means abundance of clods, which, by affording shelter, are a direct encouragement to the pest.

3. Judicious manuring to force growth.

4. Rolling the drills, if land rough and sufficiently dry, after sowing the seed. This breaks the clods,

consolidates the surface, and, by facilitating the ascent of moisture from the sub-soil, encourages germination and growth.

5. Good results have frequently attended working the land in autumn; and, in spring, sowing on a "stale" furrow.

6. Using fresh seed — which germinates more quickly and regularly, and produces stronger plants than old seed—and sowing thickly if the land is of a character to predispose to attack.

7. Dusting with lime, soot, or even road-dust, when the leaves are moist from dew or rain.

8. Various liquid dressings—*e.g.*, an emulsion of soft soap and paraffin (see p. 68), or one gallon of paraffin dissolved in seventy gallons of water, this being sufficient to dress an acre.

9. Pure water or liquid manure (the drainings from the homestead or the dung-pit, or a solution of nitrate of soda and superphosphate) applied by a water-cart or a liquid manure drill. No liquids should be applied during sunshine, therefore best early in the morning or late at night.

10. A board coated with coal tar—which must be frequently renewed—drawn over the ground catches many of the insects, which spring up and adhere to the viscid surface.

11. Top-dressing with nitrate of soda is seldom effective, on account of "the fly" being most destructive during dry weather, and under such circumstances no solid manures have a chance to act.

12. Driving sheep regularly over a field when the leaves are damp stirs up the dust which, by coating the leaves, makes the plants distasteful to the insect.

CEUTHORHYNCHUS SULCICOLLIS, Gyll. (THE CABBAGE AND TURNIP GALL WEEVIL).—*Identification* (Fig. 26).—Length—$\frac{1}{8}$–$\frac{1}{12}$", dull black; rostrum capable of being

fitted into a groove under the thorax; antennæ geniculate; thorax strongly constricted near the anterior margin (= sulcicollis); elytra sparingly downy, marked by rows of deep striæ.

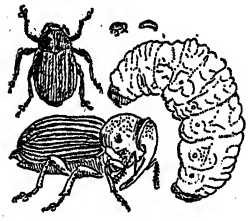


FIG. 26.—The Cabbage and Turnip Gall Weevil, showing dorsal and lateral views, and larva, mag. and nat. size. (After Taschenberg.)

Larva, yellowish-white, with a browner head; body curved, footless.

Life History.—The eggs are laid on the roots of cabbages, turnips, &c., in early summer, and the irritation induced by the larva, which appears in ten days, results in the formation of a gall-like swelling about the size of a hazel-nut. Pupation takes place in the roots or in the ground, the life-cycle being completed in about two months. In the early part of the season the insect breeds chiefly in such cruciferous weeds as charlock, and it is principally in autumn that it is found on the turnip. The winter is passed as a larva inside the gall. A large number of galls are usually found on a single root, and the damage chiefly consists in decay being induced in the swellings, and spreading throughout the plant. Very common and widely distributed.

Preventive and Remedial Measures.—

1. Eradication of charlock, for it is in this plant that the weevil chiefly breeds before the turnips are fit to attack.

2. Early consumption of affected roots, to prevent the escape of the grub into the ground.

3. Destruction of affected cabbage stocks.

4. Application of gas-lime to the land after the

removal of the crop. This is only necessary if the crop has been allowed to occupy the ground till well into spring; if cleared earlier the grubs will have been removed in the roots.

PHÆDON BETULÆ, L. (THE MUSTARD BEETLE, OR BLUE BEETLE).—*Identification.*—Length about $\frac{1}{6}''$; bluish or greenish, very lustrous; antennæ and legs black; elytra longitudinally striated.

Larva, six-footed; dingy white with black tubercles, hairs, and head.

Life History.—The imago hibernates and in spring the ♀ lays her eggs on the leaves of crucifers. On these the grubs feed, pupation ultimately occurring in the soil. By the height of summer the second generation appears, and in the Fen and Thames districts both beetles and grubs, by devouring the foliage, prove extremely destructive to the mustard, cress, horse-radish, and other cruciferous crops.

Preventive and Remedial Measures.—

1. Discontinuance for a few years of the cultivation of crops liable to infestation.

2. Burning the mustard straw, &c., as soon as possible.

3. Ploughing up and burying deeply crops that are badly attacked.

MELIGETHES ÆNEUS, Fab., a greenish beetle, about $\frac{1}{12}''$ long, is frequently very abundant on the flowers of the turnip, mustard, &c. Where such plants are cultivated for seed this insect may greatly reduce the yield. It is best combated by shaking the flower-heads over a pail containing a weak solution of carbolic acid or paraffin into which the insects fall. The early morning, or a dull day, should be selected for this work; in bright sunshine the beetles use their wings too freely to make the operation a success.

Diptera.

ANTHOMYIA BRASSICÆ, Bouché (THE CABBAGE FLY). —*Identification* (Fig. 27).—Length about ¼″, grayish in colour, covered with black hairs, which are most abundant in the ♂. In both sexes the forehead is more or less white. The thorax of the ♂ is traversed longitudinally by three black lines which are absent in the ♀.

The maggot is about ⅓″ long, yellowish-white, footless and hairless, with two black mouth hooks,

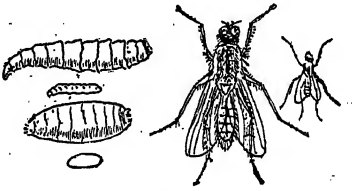


FIG. 27.—The Cabbage Fly, imago, larva, and pupa (nat. size and mag.).

while the truncated posterior extremity is surrounded by ten tubercles.

Life History.—In early spring the eggs are laid low down on the stem of the cabbage and similar plants, and in less than a fortnight the larvæ hatch out and bore into the roots and lower part of the stem of the plant. As a consequence putrefaction sets in, and the plant withers and dies. In a month the larvæ are full grown and creep into the soil to pupate, the fly appearing a fortnight later. There are at least three generations annually, and the winter is passed either as a fly or a pupa.

Preventive and Remedial Measures.—

1. Sprinkling soot round the base of the plants will largely prevent oviposition on such plants.

2. Avoidance of farmyard manure, bone meal, and organic manures generally, which attract the flies. If this is impossible the surface of the ground should get a thin sprinkling of gas lime.

3. Avoid growing cabbages, and cruciferous plants generally, too frequently on the same ground.

4. Destruction by fire of hopelessly infested plants.

(*Note.*—The maggots of several other dipterous insects live upon the roots and stems of cruciferous plants, of which the commonest is Anthomyia radicum, Mg., which very closely resembles A. Brassicæ, but the thorax is blacker and the abdomen thinner and more tapering. Its life history is, in the main, the same as that of the fly just described.)

Hymenoptera.

ATHALIA SPINARUM, Fab. (THE TURNIP SAW FLY, BLACK SLUG, BLACK PALMER, BLACK CANKER, "BLACKS," OR "NIGGERS"). — *Identification* (Fig. 18).—Wing-stretch $\frac{3}{5}''$; the prevailing colour is yellow but the head (except the mouth which is white), the antennæ (except the under-surface which is usually pale yellow), the dorsal surface of the meso-thorax, and the saw-sheath are black. The wings are tinged with yellow at the base.

The larva has twenty-two feet; when quite young it is white, but afterwards becomes greenish, and finally black (hence the popular names). When full grown it is $\frac{3}{4}''$ long, and has a pale line running down each side.

Life History.—The imagines appear in May, when the ♀ ♀ lay their eggs (200–300 each) in incisions near the margin of the leaves of the turnip and other crucifers. In less than a week the larvæ appear and devour the leaves, and in three weeks they retire to the ground and pupate in a brown case. In August the second brood of flies appear, oviposition taking place as before. The larvæ are much more numerous in autumn (September and

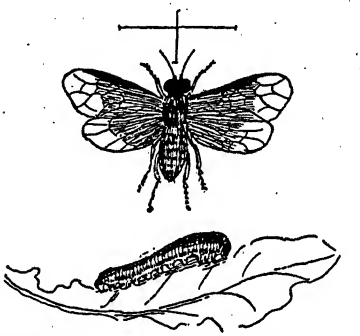


Fig 28.—The Turnip Saw Fly and larva, the former about twice nat. size. (After Taschenberg.)

October) than in summer, and as they live longer—about two months—they do much more damage. Winter is passed by the larva in a case underneath the surface of the ground, and there it pupates in spring.

The damage consists in the destruction of the tissues of the leaves, and in the case of a bad attack nothing is left but the strong veins. The insect is widely distributed, but is most destructive in the Southern counties of England.

Preventive and Remedial Measures.—

1. Ducks and poultry readily eat the larvæ, and on a small scale—as in a garden—this remedy may be practised.

2. Dusting the leaves with soot or lime.

3. Spraying the leaves with the solution described on page 68.

4. The larvæ may be beaten off the leaves with branches, and, on a large scale, branches may be fastened to a rope and dragged systematically over the field. The larvæ are not difficult to dislodge in this way, and although many will again regain their position on the plants a large proportion will be unable to do so. The best plan, however, is to sprinkle gas lime upon the creatures after they have been brushed to the ground.

5. If the crop will admit of it, branches may be attached to the front of the drill grubber, and while the branches brush the larvæ to the ground the grubber, following behind, crushes them, or so severely dusts them that few recover.

6. A field that has been infested should be deeply ploughed with a skim coulter, to bury the cocoons at such a depth that the flies will be unable to reach the surface next summer.

PIERIS BRASSICÆ, L. (THE LARGE WHITE CABBAGE BUTTERFLY).—*Identification* (Fig. 29).—Wing-stretch about $2\frac{3}{4}$″; wings white, except the base, the apex, and a mark on the posterior margin of the fore-wings and the anterior margin of the hind-wings, which are black or blackish. The ♀ has two black marks near the middle of the upper surface of each fore-wing (absent or very faintly represented in the ♂), while both sexes have two such marks on the under surface of the fore-wings.

The Larva is about $1\frac{1}{4}$″ long, 16-footed, greenish-

yellow, covered with black spots, with a yellow line running down the back, and one on each side above the feet; head black.

Pupa, marked by yellow and black spots, angular, with numerous tubercles, attached by the tail, and a silken girth round the middle, to palings, walls, &c.

Life History.—In spring the ♀ lays her greenish eggs in clusters on the under side of a variety of plants, chiefly crucifers, and in a fortnight the larvæ

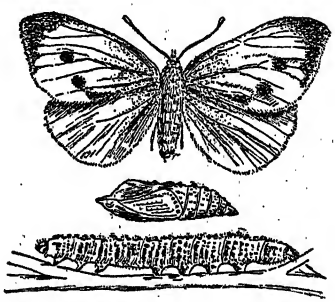


FIG. 29.—The Large White Cabbage Butterfly, ♀, with pupa and larva; the imago about three-quarters life-size.

appear. These feed upon the leaves, and in a month or so retire to a wall, fence, tree, &c., to pupate. In July and August the second brood of butterflies appears, and these lay their eggs chiefly on cabbages, cauliflowers, and similar plants, though also on Indian cress, wallflowers, &c. It is the caterpillars which result from these late-laid eggs that do most damage. Pupation takes place in September or early in October, and the imago appears in the following spring (see also p. 23). As the early and late broods

overlap somewhat, the butterfly is met with on the wing during the whole summer.

Preventive and Remedial Measures.—

1. Destroying the pupæ, especially during winter.

2. Crushing and so destroying the eggs, which will be found on the under surface of leaves, at the time when the butterfly is on the wing.

3. This insect is preyed upon by many parasites, the most important being an Ichneumon, Microgaster (Apanteles) glomerata (Fig. 30), which lays its eggs in the bodies of the caterpillars, and ultimately

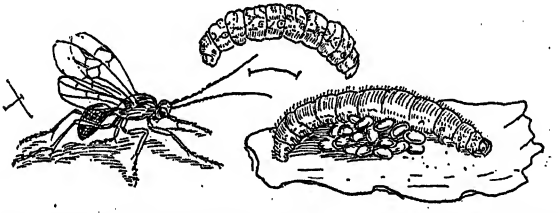


Fig. 30.—Microgaster glomerata, imago and larva, both mag. To the right is a dead caterpillar with the cocoons of Microgaster lying beside it, nat. size. (After Bos.)

pupates outside in a small yellow cocoon. Large numbers of this parasite may usually be obtained by feeding a few caterpillars in confinement for some weeks. In searching for, and destroying, the eggs of the butterfly great care must be taken not to injure the cocoons of Microgaster, which are found in clumps on the leaves.

4. Hand-picking the caterpillars, being careful not to gather any that are dead, because these have usually been killed by M. glomeratus, and contain the larvæ of this parasite, which it is so important to preserve.

5. Soot, limedust, or a weak solution of brine, applied to the leaves when the caterpillars are feeding, will prove beneficial, though it is evident that these substances cannot be applied near the time when the crop is to be utilised.

PIERIS RAPÆ, L. (THE SMALL WHITE BUTTERFLY).—This butterfly is distinguished from the former by its smaller size (wing-stretch 2″), and by the frequent occurrence of a black spot on the upper surface of the fore-wings of the ♂.

Caterpillar an inch long, and velvety to the touch, the hairs being much shorter and more numerous than in the Large White.

The eggs are laid singly, so that this insect cannot be combated by crushing the eggs. Found on all cruciferous plants, and frequently on mignonette.

PIERIS NAPI, L. (THE GREEN-VEINED WHITE BUTTERFLY).—This insect is the same size as the last, from which it differs in the anterior margin and the termination of the veins of the fore-wings being black, and in the under side of the hind-wings being yellow, while the veins are greenish-gray. In the ♀ having two black spots on the upper surface of the fore-wings, and the ♂ usually having one such mark—which may, however, be absent—and in the eggs being laid singly, this insect agrees with P. rapæ.

PLUTELLA CRUCIFERARUM, Zell. (CEROSTOMA XYLOSTELLA, Curt.), (THE DIAMOND-BACK MOTH).—*Identification* (Fig. 31).—Wing-stretch ½″; head, yellowish-white; antennæ, white with dark rings, project straight in front of the head, very conspicuous; fore-wings, narrow, yellowish-brown with darker markings, the posterior margin of each having three roughly-triangular white marks. When the wings are folded these triangular marks come together and form three white irregular diamond-shaped marks, hence the

and later on even a third generation is possible. Winter is passed as a pupa.

The most serious attack of this insect was during July and August of 1891, when the turnip crop over large areas in Great Britain, but especially in the Eastern counties, was much damaged. Undoubtedly, on this occasion, a very large proportion of the moths were blown to our shores from Denmark and Scandinavia, but the Diamond-back Moth is an insect which one may find every season in a few minutes in any turnip field from May to September, and it only requires a combination of circumstances favourable for increase to make it a pest of the first magnitude at any time. The attack of 1891, bad as it was, would have been much worse had not July of that year been characterised by unusually frequent and severe showers of very cold rain, which did more to keep the insects in check than the measures that were brought to bear against them.

Preventive and Remedial Measures.—

1. Eradication of cruciferous weeds, and suitable manuring and tillage.

2. Frequent cultivation between the drills with the drill-grubber (scuffler), on the front of which light branches have been fixed. These brush off the caterpillars, many of which are buried by the tines of the implement. It is a great advantage to follow this implement with a light drill plough, which buries the larvæ still more effectively, and earths up the lower leaves of the plants. This is the best remedial measure on a large scale.

3. Dry dressings, especially soot and quicklime dust (5 cwt. per acre), are fairly efficient, but they must be applied by a Strawsonizer arranged so as to distribute the material on the under side of the leaves.

4. Nitrate of soda, as a top-dressing, is a very doubtful remedy.

5. Liquid dressings of paraffin and other solutions (for composition see pp. 68 and 95), are moderately successful, if they can be got on to the under-leaf surface.

MAMESTRA BRASSICÆ, L. (THE CABBAGE MOTH).—*Identification* (Fig. 32).—Wing-stretch over $1\frac{1}{2}''$; fore-wings brown, with yellow and black markings, showing more or less distinct undulating yellowish transverse and marginal lines, the reniform mark

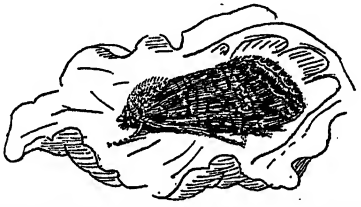


FIG. 32.—The Cabbage Moth, nat. size. (After Taschenberg.)

being fairly distinct. Hind-wings paler in colour, with a black line on the marginal fringe.

Larva, 16-footed, $1\frac{1}{2}''$ long, variable in colour, usually greenish-gray above and yellow below, with indistinct dorsal and lateral darker lines.

Life History.—Eggs laid singly in May on the leaves of cabbages, cauliflowers, turnips, &c., and in about a fortnight the larvæ appear. These conceal themselves amongst the leaves, and in a month pupate in the ground. In August the second brood of moths appears, the eggs being laid as before. The caterpillars, which live during September and October, being much more numerous than those met with

earlier in the season, do proportionately more damage. They eat their way through the hearts of cabbages, cauliflowers, &c., where they induce putrefaction, and render the plants valueless. Winter is passed as a brown pupa in the earth.

Preventive and Remedial Measures.—

1. Destruction of the pupæ when these are turned up during winter and spring tillage.
2. Hand-picking, which must be done before the caterpillars have left the outer leaves and bored into the heart.
3. Application of soap-suds or lime-water, though manifestly such substances must spoil the flavour of the produce.

Rhynchota.

APHIS BRASSICÆ, L., and APHIS RAPÆ, Curt. (CABBAGE AND TURNIP APHIDES).—*Identification.*—Both are greenish, but the colour is concealed by a bluish white dust, with which the insects cover themselves.

Life History.—(See p. 62). The insects are met with in colonies on the under side of the leaves, and are most abundant in warm dry weather in August and September.

Preventive and Remedial Measures.—Soft soap and paraffin emulsion (see p. 68).

Scale with 2 yellow spots. a brown pupa & im[illegible] appears after 4 days. Body is red & thorax yellow but mealy white powder hides it. They breed all the year [illegible]

INSECTS INJURIOUS TO THE NAT. ORDER CHENOPODIACEÆ—THE MANGEL WURZEL, BEET, &c.

Coleoptera

SILPHA OPACA, L. (THE BEET CARRION BEETLE).—*Identification.*—Length about $\frac{2}{5}''$; oblong oval; black but covered with yellowish hairs; antennæ, 11-jointed, clavate, about half the length of the body; elytra, with three longitudinal raised lines on each.

Larva about $\frac{1}{2}''$ long, black, lustrous, with six legs, superficially resembling a wood-louse.

Life History.—The eggs are laid in spring in decomposing vegetable and animal matter, though also in the soil near the base of mangels and similar plants. The grubs, which appear in about a fortnight, and feed mostly at night, live on dead organic matter, though also on the leaves of mangels, &c., where they have occasionally been known to cause much damage. Pupation ultimately takes place in the soil, where the imago is produced in autumn; and, after hibernation, oviposition takes place in spring.

Preventive and Remedial Measures.—

1. The avoidance of applying foul-smelling manures, such as slaughter-house refuse, which attract this and other carrion beetles, *e.g.*, Silpha atrata.

2. The application of soap and paraffin emulsion (see p. 68) when the grubs are at work.

Diptera

ANTHOMYIA (PEGOMYIA) BETÆ, Curt. (THE MANGEL FLY). — *Identification.*— Wing-stretch nearly ½″; body, grayish, covered with black bristles; face, white with a brown line down the centre; thorax and abdomen of ♀ traversed by inconspicuous darker lines.

Larva about ⅓″ long, whitish, tapering in front, truncated behind, furnished with two black mouth-hooks.

Life History.—The ♀ lays her eggs in June on the under side of the leaves of the mangel and beet. In a week or so the larvæ bore into the leaf and destroy the tissue between the upper and under epidermis. Distinct galleries are not made, the tissue being destroyed in patches, which give a mottled appearance to the leaves. In young plants such damaged spots may occupy the larger portion of the leaves, which consequently wither and die. In July the larvæ seek the ground and pupate in a brown case, the fly appearing in about a fortnight. Eggs are again laid as before, so that there are two, possibly even three, generations annually. Winter is passed as a pupa, to some extent also as an imago.

Preventive and Remedial Measures.—

1. Autumn cultivation, so as to conserve moisture in spring, and thus secure rapid germination of the seed and satisfactory growth in the young plants.

2. Liberal manuring, and top-dressing with nitrate of soda (1–2 cwt. per acre) on signs of attack.

3. Thick seeding.

4. Nipping off and destroying the discoloured patches, which contain the larval colonies. This, though a tedious process, is very effective.

Note.—Mangels also suffer from the attack of wireworms (see p. 40) and surface caterpillars (see p. 99.)

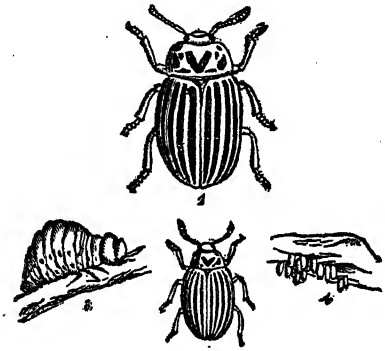
INSECTS INJURIOUS TO THE NAT. ORDER SOLANACEÆ—THE POTATO

The potato crop is practically free from insect attack in this country, for although green flies, surface caterpillars, wireworms, the caterpillar of the Death's Head Moth, and a few other insects may occasionally be found on the plants they are seldom sufficiently numerous to do any appreciable harm. In America the **Colorado Beetle** (Doryphora decemlineata, Say) does great damage to this crop, and the Governments of European countries are constantly on the alert lest it should establish itself on this side of the Atlantic. That this is a real danger is proved by the fact that, some years ago, the insect obtained a temporary footing in Germany; while in the summer of 1901 it was found breeding freely, and in considerable numbers, on a potato patch, close to Tilbury Docks, in the county of Essex. In the following spring it again appeared on the same ground, but the energetic measures adopted by the Board of Agriculture, are believed to have been successful in exterminating it.

Identification (Fig. 33).—Imago $\frac{2}{5}''$ long, elytra brownish-yellow, each traversed long itudinally by five black lines, thorax supplied with several black spots.

Larva about same length as imago, orange-coloured ʏith a black head, and six short legs.

Life History.—The imago hibernates in the ground, nd in early summer the ♀ lays her eggs in clusters n the under side of potato leaves. In a week the ɪrvæ appear and live for three to four weeks on the ›aves, finally crawling down to the ground to pupate, ɑd a fortnight later the beetle again appears. There



. 33.—The Colorado Beetle (mag. and nat. size). To the left a larva, ɴnd, to the right, eggs on the under side of a leaf. (After Ormerod.)

› several generations annually, and the damage ɪsists in the destruction of the leaves by the larvæ ɪ imagines. This is one of the most prolific of ects, each ♀ laying, it is said, from seven to twelve ɑdred eggs.

Remedial Measures consist in spraying the leaves ɦ a solution of Paris green, or in saturating the ɪlm with petroleum and burning the crop.

INSECTS INJURIOUS TO THE GENUS DAUCUS—THE CARROT CROP.

This crop is preyed upon, to a certain extent, by various insects, of which, however, the only one that is conspicuously injurious is a dipterous insect, namely,

THE CARROT FLY (PSILA ROSÆ, Fab.).—*Identification.*—Imago $\frac{1}{5}''$–$\frac{1}{6}''$ long, black, slightly downy, head and legs yellow. Antennæ three-jointed, short, yellow at the base. Wings longer than the body, with brownish veins.

Larva about as long as the fly, pale yellow, smooth, shining, destitute of hairs, footless, with two mouth-hooks, truncated behind.

Pupa, brown.

Life-History.—The winter is passed in the earth as a pupa, from which the fly appears in spring. The eggs are laid on the carrot roots, as far as possible beneath the surface of the ground. In a week the larvæ appear, and these bore into the root and throw a yellowish dust to the surface, hence the name of "carrot rust" commonly given to the attack. In two to three weeks the larvæ crawl into the earth, where they pupate, and in ten to fourteen days the fly again appears. Several generations annually. In consequence of attack the carrot leaves become yellow, and if a few roots of such plants be placed in a box with a little soil a large number of flies will be obtained in a few weeks.

Preventive and Remedial Measures.—

1. Careful preparation of the ground, so that the most favourable conditions of growth may be secured, and selection of a suitable rotation of crops.

2. Early thinning of the crop so as to disturb the soil as little as possible round the plants that are retained, and also because the flies are scarcer in the early part of the season. The crop is usually attacked only after thinning, for the two reasons that the disturbance of the soil associated with the operation enables the fly to get at the roots, and the aromatic odour disseminated by the bruised leaves and roots attracts the insect to the spot.

3. Very thin seeding so as to dispense with artificial thinning.

4. Top-dressing with soot, lime-dust, paraffin solution, &c., immediately after thinning so as to make the conditions unattractive to the fly.

5. Douching the bed heavily with water immediately after thinning so as to consolidate the loosened soil round the roots, and also to drown any flies that may be on the plants.

6. Frequent turning over of the soil during winter will expose a large proportion of the pupæ to the attack of birds. If the surface soil be buried deeply the flies will be unable to reach the surface of the ground in spring.

7. A heavy dressing of gas-lime (four to five tons per acre) immediately after an infested crop is removed from the ground.

8. Removal and destruction of visibly affected plants.

9. One gallon of spirits of tar mixed with a barrow-load of some absorbent, such as saw-dust, wood ashes, peat litter, or sand, and incorporated with the soil at the time of sowing. This quantity is sufficient to dress sixty to seventy square yards.

INSECTS INJURIOUS TO THE GENUS ALLIUM—THE ONION CROP.

This crop, like the carrot, is affected chiefly by a single dipterous insect, namely,

THE ONION FLY (ANTHOMYIA CEPARUM, Bouché = A. platura, Mg.; A. antiqua, Mg.; Phorbia cepetorum, Meade).—*Identification* (Fig. 34).—The Imago is

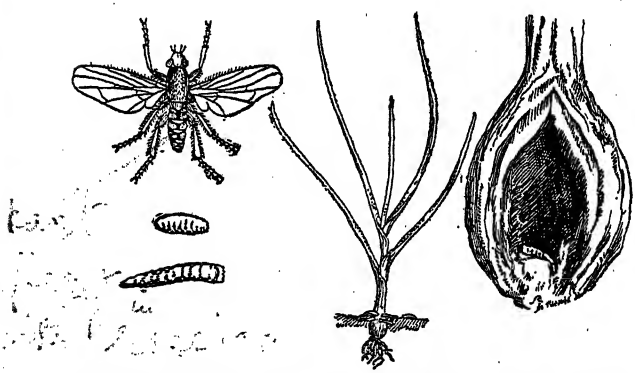


FIG. 34.—The Onion Fly, pupa and larva (mag.). To the right infested plants.

$\frac{1}{4}''$–$\frac{1}{3}''$ long, grayish-black in colour, anterior margins of wings beset with spine-like bristles, abdomen of ♂

with a dark dorsal line which is absent in the ♀; lower part of the face whitish, forehead black.

The Larva, which is as long as the fly, is white, footless, and hairless, tapering in front, truncated behind, the blunt posterior extremity being surrounded by twelve unequal-sized tubercles.

The Pupa is brown.

Life History.—The ♀ lays her eggs in early summer at the base of the leaves of the onion, and the maggots work their way down between the leaves till they reach the bulb, where they form galleries, ultimately crawling out into the earth to pupate. The duration of the various stages of the life-cycle is approximately the same as in the case of the Carrot Fly. There are several generations annually, and winter is passed as a pupa in the soil. The damage consists in the interference with growth, and in the decomposition induced by the larvæ, infested plants being recognised by their drooping, yellowish appearance.

Preventive and Remedial Measures.—The measures recommended in the case of the Carrot Fly (Nos. 1, 6, 7, 8, 9) are applicable here, but infested onions must be lifted with greater care than carrots, as they so easily come to pieces. The pest may also be combated by planting onions in the bottom of a shallow trench, and, as the plants get larger, they are gradually earthed up, so as to prevent the fly getting near the base of the leaves for the purpose of laying its eggs.

INSECTS INJURIOUS TO THE GENUS HUMULUS—THE HOP.

Although various insects may, from time to time, be found feeding on this plant, the only one that proves a veritable plague (see also p. 117) is

THE HOP APHIS, LOUSE, OR "FLY" (APHIS, OR PHORODON, HUMULI, Schrank).—*Identification.*—The wingless individuals are pale green, and about $\frac{1}{12}$" long, the winged specimens showing brown markings. In both cases there is a prominent tubercle at the base of each antenna.

Life-History (see p. 62).—It is believed that this insect migrates in large numbers to the hop from plants of the genus Prunus (plum, damson, sloe, &c.) growing in the neighbourhood. Having established itself on the hop it increases rapidly on the underside of the leaves, and by extracting the juice and covering the foliage with a gummy exudation ("honey dew") it soon induces such an unhealthy condition in the plant as to materially interfere with, if not entirely suppress, the formation of leaves, flowers, and young shoots.

The attack generally appears from the middle till the end of May, and is continued throughout the summer, being worst in cold, backward springs.

Preventive and Remedial Measures.—

1. Removal of all bines and rubbish from the hop gardens not later than February.

2. Application during early spring of slaked lime to the soil at the base of the plants. This tends to destroy insects that may be harbouring in the ground.

3. Application of insecticides to the foliage of plum and similar trees affected by Aphides in the neighbourhood of hop gardens.

4. Application of insecticides to the foliage of affected hops. These are best applied by means of a garden engine or Strawsonizer, and the dressing should be put on early and be repeated once or twice if necessary. The "wash" should be so applied that it reaches the underside of the leaves. A standard solution consists of :—

7 lbs. quassia
5 lbs. soft soap
100 gallons soft water

Boil the quassia for two hours and then add the soap, finally diluting with water to the proper strength.

Another solution consists of—

14 lbs. bitter aloes (or
2 lbs. of strong tobacco)
60 lbs. soft soap
36 gallons water.

Boil for a short time, and, for use, dilute one gallon of the mixture with 36 gallons of soft water.

INSECTS INJURIOUS TO VARIOUS GARDEN PLANTS.

Coleoptera.

OTIORRHYNCHUS PICIPES, Fab. (THE CLAY-COLOURED WEEVIL).—*Identification.*—Length, about $\frac{1}{3}''$; elytra brownish-yellow in colour, traversed by rows of striæ, each puncture being provided with a white scale.

OTIORRHYNCHUS SULCATUS, Fab. (THE BLACK VINE WEEVIL).—*Identification.*—Length nearly $\frac{1}{2}''$; elytra black, irregularly covered with grayish-yellow scales, and traversed by deep depressions.

OTIORRHYNCHUS TENEBRICOSUS, Herbst (THE RED-LEGGED GARDEN WEEVIL).—*Identification.*—Length, about $\frac{1}{2}''$; elytra black, frequently with some irregular patches of gray pubescence, striated; legs reddish.

These species of Otiorrhynchus frequently do considerable damage to various garden plants, especially fruit trees. They live, for the most part, on the leaves and young shoots, while the larvæ attack the roots. O. sulcatus is best known as a pest of the vine, though it also injures strawberries, primulas, &c., &c. The imago feeds at night on the shoots while the larva attacks the roots. The former may be collected by holding a sheet beneath the vines at night and shaking the branches; the latter may be combated by working soot, lime, or salt into the soil, though

in the case of a bad attack it may be necessary to clear out the border and replant. It is specially desirable that all the cracks and crannies in a vinery should be plugged up, as it is in these that the Weevil conceals itself during the day.

The other two species are met with on pears, plums, raspberries, &c., from which they may be removed by beating, or by suitable dressings.

CETONIA AURATA, Fab. (THE ROSE CHAFER), a golden-green beetle, about $\frac{3}{5}$″ long, is sometimes destructive to roses, though not usually to such an extent as to call for special notice.

CRIOCERIS ASPARAGI, L. (THE ASPARAGUS BEETLE). —*Identification* (Fig. 35).—Imago about $\frac{1}{4}$″ long, lustrous bluish-green in colour, bordered with red and with three yellowish spots near each margin. Thorax red, almost cylindrical.

Larva, greenish, head and the three pairs of feet black.

Life History.—In early summer the beetle is found devouring the leaves and branches of Asparagus, and there the eggs are laid. The larvæ continue the work of destruction in a similar manner, and ultimately pupate in the ground. Double generation annually.

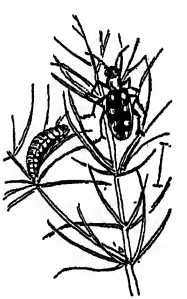


FIG. 35.—The Asparagus Beetle and larva, slightly mag. (After Taschenberg.)

Remedial Measures.—

1. Shaking the insects off the plants on to cloths held underneath.

2. Lime dust, paraffin-soap solution, and similar dressings may be applied with good results.

Diptera.

TEPHRITIS ONOPORDINIS, Fab. (THE CELERY FLY.)—*Identification* (Fig. 36).—Fly about ⅛″ long, brown-

FIG. 36.—The Celery Fly, and an infested plant with the upper epidermis removed to show the larvæ underneath (mag.).

ish in colour, the wings being also marked by brown patches.

The larva is greenish, legless, tapering in front, truncated behind.

Life History.—The fly lays her eggs on the leaves

of celery and parsnips in early summer, and the larvæ, which hatch out in a few days, excavate the tissues between the upper and under epidermis. In about two weeks pupation takes place in the ground —occasionally on the plant—and in a short time the imago again appears. Several generations annually. The damage consists in the destruction of the leaves, and in the consequent interference with plant-nutrition.

Preventive and Remedial Measures.—

1. The deep burial of soil from infested celery and parsnip beds.
2. Crushing the larvæ in the infested leaves.
3. Destruction by fire of badly affected plants.
4. Dusting the leaves with a mixture of equal parts of soot and slaked lime.

Lepidoptera.

Surface Caterpillars.—These belong almost exclusively to the moth-genus Agrotis—using the term in its widest sense—which again is included in the family Noctuidæ.

The Noctuidæ are chiefly distinguished by the presence of an orbicular and a reniform mark near the centre of each fore-wing, while the following are the chief characters of the genus Agrotis:—

Prevailing colours of the body and fore-wings are gray, drab, and brown, which harmonise with the dead leaves, stones, and clods of earth amongst which they so frequently rest. When disturbed they fly heavily for but a short distance, and then settle on the ground or on low herbage.

The hind-wings are paler in colour, sometimes almost white, in other cases yellow, and frequently with a dark line or band near the margin.

The larvæ, which, when full grown, are usually considerably over an inch in length, have sixteen feet, and are smooth, fleshy, and inconspicuous in colour, like the soil in which they lie concealed during the day. At night they feed on roots, or crawl to the surface of the ground and devour young plants of the most varied description, even seedling trees often suffering very severely from the attack. The leaves alone may be nibbled, or the stems may be clean cut through and the upper part be left lying

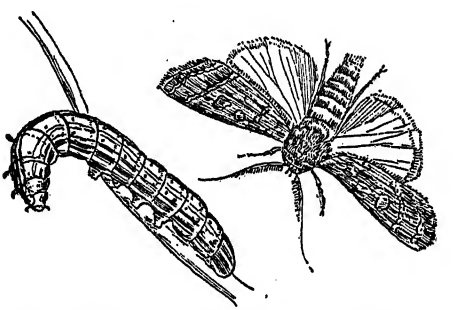


Fig. 87.—The Turnip Moth or Common Dart and Caterpillar, nat. size. (After Curtis.)

on the ground, the work of the creatures bearing a strong resemblance to an attack of voles. During the day they retreat underneath stones, clods, &c., or withdraw into burrows like worms, so that their presence is not suspected. On the approach of winter the caterpillars retreat into earth-cells where they hibernate, and from which, on the appearance of genial weather in spring, they again come forth to feed.

About the month of May they finally change to brown pupæ in the soil, and from these the moths

appear during early summer, to lay their eggs on the ground near suitable plants. With very few exceptions the generation is a single one, but as the larvæ feed both before and after winter they are capable of doing the maximum amount of damage.

The genus is extremely rich in species, the more economically important being A. segetum (Fig. 37), the Turnip Moth; A. exclamationis, the Heart and Dart; A. nigricans, the Garden Dart, and A. pronuba,

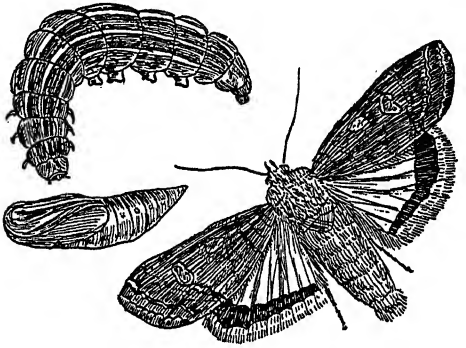


FIG. 38.—The Great Yellow Underwing, with larva and pupa, nat. size. (After Curtis.)

the Great Yellow Underwing (Fig. 38). The last is frequently placed in a separate genus, Triphæna, and is easily recognised by the brilliant orange-yellow under-wings, with their black band near the outer margin.

Preventive and Remedial Measures.—

1. Frequent stirring of the soil during winter and spring destroys many of the larvæ or exposes them to the attack of birds.

2. The moths may be caught at night in summer in large numbers by attracting them to a mixture of sugar and rum, when they may be destroyed. They will also flock to a bright light, and special lamps, which act as traps, may be obtained for their capture. These measures are only applicable to garden or nursery conditions.

3. When the larvæ are at work on a large scale, the frequent use of the horse hoe amongst drilled crops

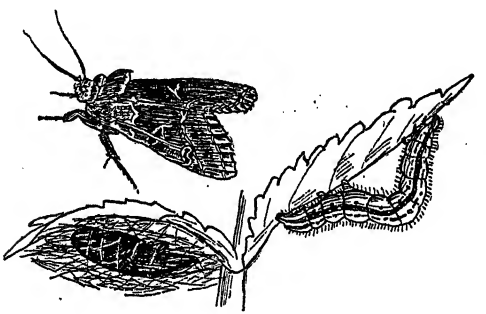


FIG. 39.—The Silver Y-Moth, with larva and pupa, nat. size. (After Curtis.)

is the best cure. In gardens and nurseries the larvæ may be collected after being turned up to the surface by a hoe, or even by a sharp-pointed stick.

4. Fresh gas-lime worked into infested land in autumn does a certain amount of good.

PLUSIA GAMMA, L. (THE SILVER Y-MOTH).—*Identification* (Fig. 39).—Fore-wings about $1\frac{1}{2}$″ from tip to tip, grayish, but covered by many fine, wavy, reddish-brown lines and markings, each wing bearing a silver-white Y-shaped mark. Hind-wings brown, paler towards the base, bordered with a whitish fringe.

Larva fully 1¼″ long, green, with six fine longitudinal white lines, and a yellower line near the base of the feet. Possesses twelve feet, and a sparing covering of stiff hairs.

Life History.—The eggs are laid during summer on the under-side of the leaves of practically all cultivated herbaceous plants (cabbage, beetroot, peas, vetches, clover, stocks, &c.), and in a fortnight the larvæ appear and proceed to destroy the leaves. In a month or so they pupate in a thin web amongst the leaves, and a fortnight later the moth is produced. There are two or even more generations annually, the winter being passed for the most part as a half-grown larva, though the imago also hibernates.

Remedial Measures.—

1. Hand picking.
2. Poultry greedily devour the caterpillars, and may be employed for this purpose on a small scale.

Orthoptera.

FORFICULA AURICULARIA, L. (THE EARWIG).—*Identification.*—Length ½″–¾″. Head heart-shaped, reddish-brown in colour; antennæ 15-jointed and bristle-like; thorax quadrilateral; body dark brown; legs paler in colour; the last abdominal segment bears a pair of claspers which are nearly straight and smooth in the ♀, but more bent and furnished with dentations in the ♂ (Fig. 40). The fore-wings are short and pergamentous, the hind-wings are membraneous and folded beneath the fore-wings.

Life History.—During the day the earwig conceals itself underneath loose bark, boards, dead leaves, &c., and at night it attacks flowers,—especially the Dahlia and Nasturtium—ripe fruit, &c., though it also lives on the dead bodies of other insects, and

on animal food generally. In spring the ♀ lays her eggs in clumps underneath all sorts of cover, and displays the rare characteristic amongst insects of remaining on guard beside them till they are hatched in three or four weeks. The larvæ moult several times, and gradually pass into the imago-stage without becoming quiescent pupæ (incomplete metamorphosis). The winter is passed as an imago.

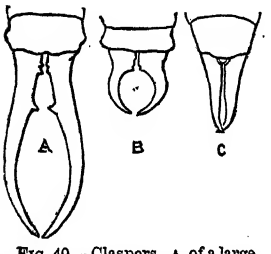


FIG. 40.—Claspers, A, of a large, and B, of a small ♂; C, of a ♀.

Preventive and Remedial Measures.—

1. Placing small inverted flower pots, containing some paper, on the top of poles near the plants to be protected. The earwigs will congregate in such places, from which they may daily be taken out and destroyed.

2. On a large scale bundles of straw, twigs, &c., may be used to attract the insects. These are taken to a bare piece of ground every morning, and the earwigs which are shaken from them are stamped to death.

Diptera.

HYPODERMA BOVIS, De Geer (THE OX WARBLE FLY). —*Identification* (Fig. 41).—The imago is fully ½" long, for the most part black, covered by dense pubescence; the forehead is pale yellow; the front of the thorax is

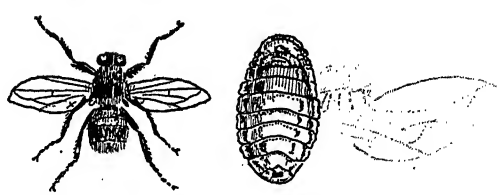


FIG. 41.—The Ox Warble Fly and larva (nat. size).

brownish, the hinder part black; the apex of the abdomen is furnished with reddish-yellow hairs. The wings are somewhat smoky, the poisers being dark brown protected by large white scales.

The larva, when full grown, is about an inch long, oval in shape, of a dark brown colour, very tough, and much wrinkled. The breathing pores are situated in a depression on the last segment.

The Pupa is black.

Life History.—During the months from June to September the ♀ lays her flattish, white eggs on the hair of the back of cattle, and the resulting maggots bore into the skin. For the first few months the maggot is white, and occupies no fixed position in the animal, but during winter it locates itself in a particular spot, where it feeds upon the purulent matter due to inflammation in the subcutaneous tissues. Here it grows rapidly and becomes yellow and then brown, and gives rise to the well-known swellings that are known as warbles. The sac which contains the insect communicates with the outside air by means of a small aperture in the hide.

Towards the end of spring, or in early summer, the maggot works its way out of the skin—generally between five and eight in the morning—and drops on to the ground, where it pupates a short distance underneath the surface. A month later the imago appears, so that the generation is a single one.

The damage done by this insect is enormous, the Newcastle Hide Protection Society, for instance, reporting that the hides dealt with in that town alone in 1892 had been damaged by warbles to the extent of £14,000. Besides the injury to the leather H. bovis causes great damage by unsettling cattle and preventing them thriving properly. When cattle discover that the fly is hovering near they rush wildly about the field; and the constant irritation to which the larva subjects them when located in the skin is no less detrimental to the animals. The flesh in the neighbourhood of the warbles is also much reduced in value, being covered by a jelly-like substance known as "licked beef."

Preventive and Remedial Measures.—

1. Once a month during summer and early autumn grazing cattle should have their backs anointed with

train oil, or, better still, with a mixture consisting of one gallon of train oil, one pint of spirits of tar, and one pound of flowers of sulphur.

2. When the warbles are discovered on animals the hair should be clipped off in their neighbourhood and the aperture carefully plugged up by a mixture consisting of ten parts of cart grease and one part of sulphur, or by McDougall's sheep dip.

3. When well grown the maggots may be removed from the skin by pressure.

Note.—Another species, H. EQUI is occasionally

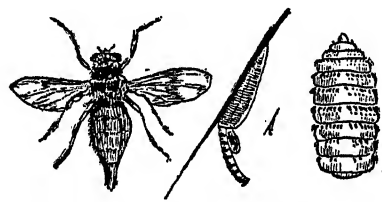


FIG. 42.—The Horse Bot Fly and larva (nat. size.) In the centre is a larva in process of emerging from an egg which is attached to a hair (mag.).

met with on horses, but it is too rare to call for a special description.

GASTRUS OR GASTROPHILUS EQUI, Fab. (THE HORSE BOT FLY).—*Identification* (Fig. 42).—Imago fully $\frac{1}{2}$" long, for the most part covered by brownish or yellowish-red hairs; wings with brownish markings. The larva when full grown is $\frac{3}{4}$" long, pale brown in colour, tapering in front, blunt behind. The body consists of eleven segments, of which Nos. 2 to 8 possess two girdles of prominent spines, such spines being confined to the ventral surface on the ninth and tenth segments.

The Pupa is black, the eggs white.

Life History.—During summer the ♀ attaches her conical eggs by a viscid substance to the hair of the mane, neck, shoulders, and fore-legs of the horse where—especially on dark-coloured horses—the eggs may frequently be found. In a week or ten days the eggs hatch, and the larvæ so irritate the skin that the horse seeks relief by licking, and in this way the maggots get into the mouth and finally into the stomach and intestines, to the walls of which they firmly attach themselves by means of prominent mouth-hooks. There they live all through the autumn, winter, and spring and cause great irritation and inflammation. In early summer they may be found in abundance in the rectum. Finally they release their hold and pass out in the dung, where they pupate about June, and a month later the imago appears. Generation, single. Appears to be commonest in the North of Scotland and in horses imported from Norway and the Danubian countries.

Preventive and Remedial Measures.—

1. Keeping the hair short.
2. Applying a strong-smelling solution to keep off the flies (*see* Ox Warble Fly).
3. Frequent examination of the hair of horses at grass, and removal of eggs by means of warm water with a little potash dissolved in it.
4. Supplying horses that are attacked with good nourishment to prevent emaciation.
5. Internal remedies which would remove the maggots are too dangerous to the horse's health to be recommended.

Oestrus ovis, L. (The Sheep Bot or Nostril Fly).—*Identification.*—Length of fly about ½″; general colour, yellowish-white streaked with black; legs and face red, wings perfectly transparent, abdomen practically hairless.

The Larva is about 1″ long, tapering to the head, which has two mouth-hooks, white when young, with dark bands when mature. The segments bear tubercles on the dorsal, and spines on the ventral surface.

Life History.—On the wing during late summer, and when the sheep recognise its hum they try to avoid it by bruising their noses against the ground. The ♀ retains her eggs till the maggots are hatched (viviparous reproduction) when they are deposited at the edge of the sheep's nostril. The irritation due to the maggots causes the sheep to shake its head and rub its nose on its fore-legs, &c. Ultimately the maggots work their way up into the cavities of the nose and, if present, the horns, where they remain for about nine months. They ultimately leave the sheep, usually during a fit of sneezing, and turn into black or dark brown pupæ in the ground, and in six or seven weeks the fly appears. Generation single, insect not common.

The symptoms of attack are an outflow of mucus from the nose, and the animal shaking its head, and rubbing its nose on its legs, the ground, palings, walls, &c. Young sheep are more subject to attack than older animals.

Preventive and Remedial Measures.—

1. Not grazing sheep near trees, for it is there that the pest is most abundant.

2. When sheep show symptoms of attack in autumn they should get some powder (snuff, pepper, &c.) to induce sneezing, whereby most of the maggots may be got rid of while still young.

Melophagus ovinus, L. (The Sheep Ked or Kade).—This insect is classed with the Diptera (of which it is an apterous form), but its life-history is so peculiar that it is sometimes placed in a separate

order, Pupipara, which signifies that the young are born as pupæ. This, however, is not quite correct. It is frequently, though erroneously, called the "Sheep Tick" (see p. 119).

Identification (Fig. 43).—Imago about ¼" long, wingless with a compressed leathery body which is reddish-brown in front, darker behind, and covered by short hairs. The apex of the abdomen is slightly excised.

Fig. 43.—The Sheep Ked and pupa (slightly mag.).

Life History.—The eggs hatch out in the body of the ♀, and there the maggots remain, being nourished by a secretion from two glands in the oviduct till they are full grown, when they are expelled from the creature's body, and almost immediately afterwards the skin shrivels up and the insect pupates inside (coarctate pupa). Hibernation takes place, for the most part, in the pupal stage. Number of generations uncertain.

The Imago lives on the fatty substance of the wool and on the blood of sheep.

Preventive and Remedial Measures.—These consist in dipping or bathing the sheep, for which many patent dips are available. On a large scale, however, flockmasters may compound quite as efficient and much cheaper dips, *e.g.*—

2 lbs. arsenic (arsenious anhydride)
2 lbs. soda (sodium bicarbonate)
3 quarts spirits of tar

The arsenic and soda are boiled together in five gallons of water till dissolved, after which the solution is diluted to about eighty gallons and the spirits of tar added. One gallon of crude carbolic acid may be

used instead of the spirits of tar. In both cases the quantities suffice for one hundred sheep at a cost of about 2*s.* 6*d.*

LUCILIA SERICATA, Mg. (THE SHEEP MAGGOT FLY). —*Identification.*—The fly is about ⅓″ long, golden-green in colour with a bluish lustre. The maggot is white, and destitute of head or feet; when full grown it is about ½″ long.

Life History.—The ♀ deposits her eggs on the wool of sheep near the base of the tail (sometimes on diseased feet or on wounds); and especially on such sheep as are dirty in that region. The eggs are deposited in clusters of about a dozen, and a single fly lays several hundreds. These hatch out within twenty-four hours, and the maggots quickly seek the skin, on which they live, and into which they bore in course of a few days. In two or three weeks the maggots are full grown, when they drop to the ground, and change to brown pupæ, the fly appearing in a couple of weeks. There are several generations annually.

In warm moist (*i.e.*, "muggy") weather in summer and autumn this is the most serious pest with which flockmasters have to contend. The sheep require constant attention by a careful and experienced shepherd, and if not treated at once the maggots will break the skin in two or three days, and death rapidly follows. The symptoms of attack are—restlessness, separation from the flock, discoloration and dampness of the wool, attempts by the sheep to reach its hind-quarters with its mouth, frequent shaking of the tail, rubbing against banks, fences, &c.

Preventive and Remedial Measures.—The success of these depends upon the attack being dealt with on the appearance of the first symptoms; if once the skin

is badly broken the sheep seldom regains its original condition.

1. Removal of filthy wool by clipping or careful handwashing.

2. Keeping the sheep out of rough, damp pastures, especially where strong herbage or trees abound.

3. Frequent dipping with arsenic and sulphur dips.

4. Careful removal of the maggots with simultaneous application of strong smelling solutions, *e.g.*, paraffin, turpentine, spirits of tar, carbolic acid. The first three should not be used if the skin has been broken; in that case a solution of carbolic acid and sulphur is most serviceable. Cuff's Fly Oil is the best of the "patent" dressings.

Note.—This is not the only fly that deposits its eggs on sheep, though it is the one usually met with. L. cæsar, L., is frequently the cause of sheep-maggots.

Rhynchota.

PEDICULIDÆ (LICE).—*General Characters.*—The mouth is situated at the end of a protrusible suctorial tube, body compressed and destitute of wings, antennæ 5-jointed, eyes absent or only represented by rudimentary ocelli, metamorphosis incomplete.

Life History.—The eggs ("Nits") are attached by a viscid fluid to the hair, and in a week the larvæ appear. These moult several times, and gradually become imagines without undergoing any distinct metamorphosis. The whole life cycle lasts about a month.

There are a very large number of species, and most animals are more or less affected. They are most

APPENDIX.

In the foregoing pages we have confined our attention to the true insects—that is to say, to Arthropods which possess one pair of antennæ and three pairs of legs; and which have the head, thorax, and abdomen distinct. In popular language, however, the term insect has a wider application, and is made to embrace such creatures as centipedes, millepedes, spiders, mites, ticks, &c. As but few of these are positively harmful to crops or animals, the size of this book will not be materially enlarged if we include them here, and thus, as it were, round off the subject.

THE CLASS ARACHNOIDEA.

This class contains a considerable number of orders, though most of them are of indifferent interest to farmers and gardeners, *e.g.*, true spiders, scorpions, &c. One Order, however, (Acarina) contains a number of families, genera, and species that are extremely troublesome, and even dangerous, both to plants and animals.

The Family **Acaridæ** is characterised by the minute, frequently microscopic, size of its members, whose bodies are covered by hairs or bristles, and which are devoid of eyes, possess a biting or sucking mouth, and many of the parasitic

forms have stalked suctorial discs on the feet. In their case the abdomen and cephalothorax show no differentation, and the abdomen is not segmented. They have normally eight legs when mature, though only six in their earlier stages. They live on dead organic matter (*e.g.*, cheese mites), or on living animals, where they occasion the diseases known as itch, scab, and mange.

The mites causing these diseases may be arranged in the following four genera :—

(1) SARCOPTES, Ltr., live underneath the surface of the skin ; and are further distinguished by their four anterior legs being attached to the margin of the body, while the four posterior ones are attached to the surface of the abdomen. They are microscopic in size, never exceeding $\frac{1}{50}''$ in length.

The ♀ burrows into the skin and lays her eggs. These hatch within a week, and in a fortnight or less the new generation is capable of reproduction, so that the rate of increase is a very rapid one.

Sarcoptes scabiei, L., causes the itch in the human subject.

S. cati, Hering, is met with on cats, rats, and rabbits.

S. squamiferus, Fürst., is met with on dogs and pigs.

S. mutans, Robin, is a viviparous species, which induces malformations of the feet and combs of poultry.

(2) DERMATOCOPTES, Fürst. (PSOROPTES, Gerv.), live on the surface of the skin and suck the blood. The legs are all attached to the margin of the body, the proboscis is long and pointed, and the suctorial discs are borne on three-jointed stalks.

The creatures live in colonies, and the eggs are attached to the skin of the host by a viscid material.

D. communis, Fürst. (*longirostris*, Még.), and its sub-species, is the cause of scab in the sheep, and of forms of mange in the horse and ox. Sheep-scab is characterised by the following symptoms:—The animals are restless and rub themselves against walls, palings, &c. On parting the wool and examining the skin one finds yellow globules containing a fluid, and the fleece is matted with a brownish substance. The wool becomes white and brittle, and, though separating from the skin, adheres together, owing to the viscid substance with which it is permeated. The sheep rapidly lose condition, and may even die from the attack.

It is not difficult to cure, if taken in time, by bathing in the following solution (Archibald's prescription), the quantities sufficing for one hundred sheep:—

Water 80 gallons
Spirits of tar 2 gallons
Tobacco paper 10 lbs.
Soft soap 10 lbs.
Bicarb. soda 10 lbs.

The tobacco paper should first be infused in boiling water for half an hour, after which the other constituents are added. If a cure is not effected by one application, the treatment may be repeated in ten days.

(3) DERMATOPHAGUS, Fürst. (SYMBIOTES, Gerl.), the species of which live on the scales of the skin, and have a blunt proboscis and a single-jointed suctorial disc. All the legs are attached to the margin of the body.

The eggs are attached to the hair or skin, and in three days the six-footed mite appears, which in a week has obtained its full complement of legs and is capable of reproduction. Both this and the immediately preceding genus are somewhat larger than

Sarcoptes, and can be distinguished by the naked eye.

D. spathiferus, Még., is met with both on cattle and horses, where it produces mange, most frequently near the root of the tail. As this parasite does not suck blood, it is not such a serious pest as the members of the preceding genera; still the itch which it occasions is very unsettling to live stock, and interferes materially with their thriving.

There are many prescriptions for mange, one of the best being to wash the infested spot thoroughly with soap and water, and, after twelve hours, to subject it to a good brushing and combing. It should then be treated with a solution consisting of one part of creosote, ten parts of methylated spirit, and fifteen parts of water.

(4) The genus DEMODEX, Sim., contains very minute species, which possess only two pairs of legs, and live in the sebaceous glands and follicles at the roots of hairs. The commonest species is *Demodex folliculorum*, Owen, which causes small black spots near the base of the nose and elsewhere on the face of human beings. The same or an allied species establishes itself in the hair follicles of the dog, where it occasions the worst form of mange to which that animal is subject. When thoroughly established the disease is practically incurable, though in its earlier stages it may be got rid of by dosing the dog internally with sulphur, and externally with a lotion consisting of one part of benzine to four parts of lard.

The Family **Trombidiidæ** contains small mites with a semi-transparent body, which, with the rather long legs, is well provided with hairs. The best-known member of this family is TETRANYCHUS TELARIUS, L. (THE RED SPIDER), which is so common on hops, hothouse and other plants (Fig. 44). It is about $\frac{1}{50}''$ long,

oval in form, reddish in colour, with a dark spot behi each shoulder. It spins an extremely fine net the under-side of leaves, beneath which the coloni subsist on the juices extracted from the parenchym

The pest may be successfully combated in a varie of ways. Hothouses may be fumigated by the co bustion of tobacco-paper, or by coating the hot-wat pipes with a composition consisting of lime, bla sulphur, and water. The temperature of the pip causes the sulphur to evaporate, and the mild fum are sufficient to exterminate the pests.

T. (OR LEPTUS) AUTUMNALIS, Shaw (THE HARVEST GOOSEBERRY BUG), which is scarcely visible to tl naked eye, is reddish-yellow in colour, and possesses well-developed sucking mouth. It lives on the folia of gooseberry, currant, and other bushes, as well upon cereals, grass, and her age generally. From suc places it transfers itself in la summer and autumn to th skin of human beings an animals, into which it rapidl burrows, and causes extrem irritation and itchiness, an even mild inflammation. T would appear to be chiefly, not exclusively, when in th immature (*i.e.*, six-legged c larval) condition that th harvest bug attacks men an animals. A weak solution c carbonate of ammonia o benzine will relieve the irrita tion, and cause the creatures to withdraw from the skir

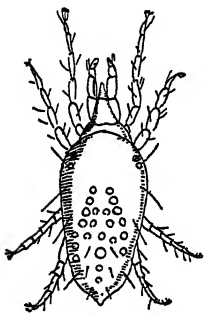


FIG. 44.—The Red Spider, much mag. (After Murray.)

The Family **Ixodidæ (The Ticks)** is in many re spects of great interest, and contains species whic

are important parasites on some of our domestic animals.

Ticks are to be met with on grass and other plants, from which, at this stage of their life, they derive their nourishment. While subsisting on a vegetable diet they are only about $\frac{1}{6}''$ to $\frac{1}{8}''$ in length, and move about with ease. Should a suitable animal come within reach of a female tick she attaches herself to it, pushes her rostrum into the skin, and proceeds to suck the blood. In this position she will remain for some weeks, and the quantity of blood which she imbibes, as well as the development of the eggs, causes the abdomen to swell greatly, so that it becomes as large as a pea or small bean. She then drops to the ground, where, however, she is now incapable of much motion, and proceeds to lay her eggs. If such females be examined the small inconspicuous male will often be found firmly attached to the ventral surface. The male tick never attaches itself to the domestic animals, and, in fact, would appear to live largely, if not altogether, as a parasite upon the female.

The two commonest species are IXODES RICINUS, L. which attacks the dog, and I. REDUVIUS, De Geer (Fig. 45), which is found on sheep. The female of the latter is reddish-yellow until satiated with blood, when she assumes a leaden colour. In the former condition she measures about $\frac{1}{6}''$, in the latter about $\frac{1}{2}''$.

FIG. 45.—I. reduvius in the distended condition (nat. size).

In certain parts of Britain, notably the Border districts, the sheep tick is very common on hill pastures, where, in spring and early summer, it attacks the sheep—especially on the under side of the legs where wool is

scanty—and, by introducing a bacterium to the animal's blood, occasions the disease known as Louping Ill. This disease is characterised by trembling, paralysis, or convulsions, and is very fatal. Burning the herbage and dipping the sheep in spring would appear to be the only practicable preventive measures.

The small so-called "Face Tick," often abundant on the head of sheep, is the larval and pupal stage of I. REDUVIUS.

THE CLASS MYRIAPODA

The two most important families in this class are the Julidæ or Snake Millepedes, and the Scolopendriæ or Centipedes. The latter are exclusively carnivorous, and by preying on insects and destroying decomposing animal matter are decidedly beneficial. They may be recognised by their flattened body, each segment of which bears only one pair of legs. They are also peculiar in having the first pair of legs modified into a sort of second pair of mandibles, with a poison gland in each. The broadest British species is **Lithobius forficatus**, L., which is about an inch long and of a lustrous reddish-brown colour. It is commonly met with beneath stones, loose bark, &c.

The JULIDÆ, on the other hand, live chiefly on vegetable matter. They have a cylindrical or semi-cylindrical body, each segment of which bears two pairs of legs, with the exception of the thoracic segments, which possess but one pair each. When disturbed they generally throw the body into a snake-like coil.

The eggs are laid in the ground, and the little millepedes which emerge from them have only three pairs of legs, but with each moult the number increases till they may possess upwards of fifty pairs.

Instances of material damage having been done to plants by millepedes are very rare, though they are not infrequently found in cavities on the roots of mangels, turnips, carrots, &c. In most cases, however, they find an entrance through a wound or decayed spot, and are not the primary cause of the injury. They have also been known to injure the roots and stems of young seedlings.

They are most likely to appear in large numbers in gardens or fields which have been heavily dressed with decomposing organic matter, such as leaf mould or composts, in which they are apt to collect, and rapidly multiply.

One of the commonest species is **Julus terrestris, L.** (Fig. 46), which is about an inch long, of a dark-

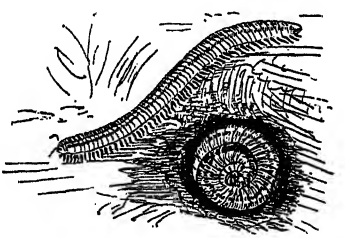


FIG. 46.—Julus terrestris, slightly mag. (After Bos.)

brown colour, but paler along the sides, with a short process projecting from the dorsal surface of the penultimate segment.

The best remedial measure consists in applications of soot or gas-lime, and these substances should be freely mixed with composts that are seen to hold many millepedes.

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